FEBRUARY

THE JOURNAL OF THE AMERICAN DENTAL ASSOCIATION

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Vice President of the American Dental Association

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Original Communications

THE PRODUCTION AND PREVENTION OF DENTAL CARIES*

By MARY CALDWELL AGNEW, M.A., R. GORDON AGNEW, B.A., D.D.S., and FREDERICK F. TISDALL, M.D., F.R.C.P.(c)

PROBABLY the earliest record of the occurrence of dental caries is found in the writings of the Chinese Emperor Huang Ti,[1] about 2570 B.C. Dental disease is divided by this writer into three types: *fong ya,* or inflammatory conditions; *chong ya,* or caries, and *ya kan,* or diseases of the soft investing tissues.

Dental disorders were not limited to the ancient Chinese, the early Egyptians being similarly afflicted. Evidence of this has been obtained both from a study of their ancient inscriptions and from examination of their skulls. Using the latter method, Elliott Smith[2] found that the well-to-do classes that lived on luxurious diets showed dental caries and alveolar abscesses as commonly as do Europeans today. The poorer classes that lived on coarse uncooked diets were relatively immune to these diseases.

The examination of 364 skulls dating from the Stone Age,[3] which were found in England, reveals the presence of caries in only sixty-four instances; which would indicate that it was much less common in those far-off times than it is at present.

Evidence that dental disease occurred among the Greeks is shown by the writings of Hippocrates (400 B.C.),[4] who supported the idea that toothache was caused by stagnation of depraved juices in the tooth, and, later, by Aristotle (384-322 B.C.),[5] who suggested, with

*From the Department of Paediatrics, University of Toronto; under the direction of Alan Brown, M.D., and the Faculty of Dentistry, West China Union University.

1. Agnew, R. G.: J. West China Border Res. Soc., 3:61, 1926-1929.

2. Smith, E., quoted by Ruffer, M. A.: Studies in Paleopathology of Egypt, University of Chicago Press, 1921, p. 293.

3. Mummery, J. R.: Tr. Odont. Soc. Great Britain, 2, 1870.

4. Guerini, Vincenzo: History of Dentistry, Philadelphia: Lea & Febiger, 1909, p. 47.

5. Footnote 4, p. 61.

his remarkable acuity, that the viscous softness of the fig caused small particles to adhere to the gums and insinuate themselves into the dental interstices where they very readily became the cause of putrefactive processes, with resultant damage to the teeth. Unfortunately, there is no statement in the work of these Greek authors on the relative prevalence of the disease. The first suggestion that caries is associated with defective nutrition comes from Galen (second century A.D.),[6] who stated that a deficiency of nourishment not only caused the teeth to die away but also enlarged the cavities.

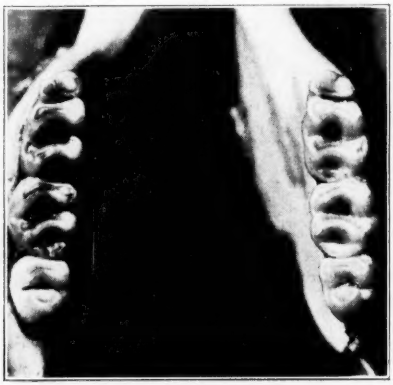

Fig. 1.—Normal jaw of rat showing six lower molar teeth (dried). The shadows in the sulci do not indicate pathologic change but are due to the narrow deep grooves characteristic of the rat molar. Absence of disease was confirmed by subsequent microscopic examination.

In more recent times, the writings of Krauterman (1732),[7] Bourdet (1757),[8] Bucking (1782),[9] and Tomes (1873),[10] give evidence of the prevalence of caries. During the past twenty years, numerous surveys[11] have indicated that approximately 95 per cent of children suffer from this disease. At the present time, there is probably no other disease to which the human body is heir that is so widespread or so fraught with potential danger to the health of the individual.

As one would expect, a tremendous amount of work has been done in an attempt to discover the various factors in the development of this common disease. In this paper, no attempt will be made

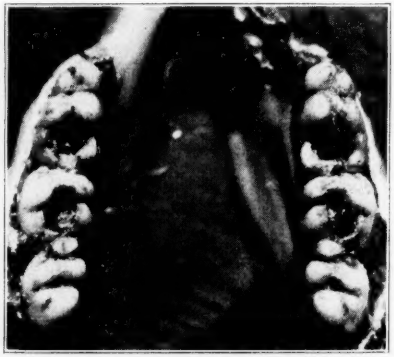

Fig. 2.—Carious molar teeth in rat (dried lower jaw). The microscopic similarity to human occlusal caries as to areas involved and contours of cavities is evident. There is an absence of cusp fracture or other artefact.

6. Footnote 4, p. 108.

7. Krauterman: Sicherer Augen-und Kahnarzt, 1732.

8. Bourdet: Recherches et observations sur toutes les parties de l'art du dentiste, 1757.

9. Footnote 4, p. 321.

10. Tomes, C. S.: Manual of Dental Anatomy, Philadelphia: P. Blackiston's Son & Co., 1914.

11. Milberry, G. S.: Mouth Health Quarterly, 1, No. 1 (Oct.) 1931. Howe, P. R., Mouth Health Quarterly, 1, No. 1 (Oct.) 1931. Brekhus, P. J.: Report on Dental Caries in 10,445 University Students, J. A. D. A., 18: 1350 (July) 1931. Van Ingen, P.: White House Conference on Child Health and Protection, New York: Century Company, 1932, p. 96.

to discuss this work in detail, as this has been done adequately by Mellanby,[12] Bunting,[13] Kesel,[14] Hatton,[15] Bing[16] and others; but a brief review of some of the recent work will perhaps not be out of place.

One of the earliest experimental studies on the relation of diet to dental caries was started by May Mellanby[17] in 1917 and is still being carried on. Her results up-to-date have led her to conclude that "the problem of dental caries and periodontal disease is fundamentally a problem of nutrition" and that a lack of vitamin D is an important etiologic factor. Howe[18] reported that by feeding guinea-pigs diets deficient in the fat soluble vitamin (since known to consist of both vitamin A and vitamin D) and the antiscorbutic vitamin, definite lesions in the teeth quite similar to dental caries were produced.

Experimental production of carious lesions in the rat analogous to those found in man was accomplished by McCollum and Grieves[19] in 1922 by disturbing the calcium and phosphorus balance in the diet and by giving an insufficient amount of the fat soluble vitamin (vitamins A and D). Toverud[20] was able to cause caries-like lesions in rats by feeding diets low in calcium and fat soluble vitamins.

In 1925, Bunting[21] reported that when he reduced the calcium and butterfat in McCollum's stock diet to below that required by the animal, caries-like defects resulted. Marshall[22] reported that similar lesions developed in older rats that were fed diets deficient

TABLE 1.—ABSENCE OF CARIES IN ANIMALS FED NORMAL DIETS*

Diet	Age of Rats Months	No. of Rats	Macroscopic Caries	Microscopic Caries
Diet 1....	2 to 5	21	o	—
Diet 1....	6 to 12	138	o	24 examined, no caries found
Diet 1....	12 to 18	30	o	—
Diet 11-A	2 to 5	73	o	23 examined, no caries found
Diet 11-A	6 to 13	103	o	24 examined, no caries found
Total		365	o	71 examined, no caries found

* In this and the following tables +, denotes presence of caries; o, absence of caries; —, not examined microscopically.

12. Mellanby, May: Experiments on Dogs, Rabbits and Rats, and Investigations on Man, Which Indicate Power of Certain Food Factors to Prevent and Control Dental Diseases, J. A. D. A., 17:1456 (Aug.) 1930.

13. Bunting, R. W.: Review of Recent Researches on Dental Caries, J. A. D. A., 18: 785 (May) 1931.

14. Kesel, R. G.: What Do We Know About Dental Caries? (A Critical Review of Recent Investigations), J. A. D. A., 19:903 (June) 1932.

15. Hatton, E. H.: J. A. D. A., Caries: Résumé of Knowledge of Its Action, Together with Some of the More Recent Research Work, 19:1398 (Aug.) 1932.

16. Bing, F. C.: Diet and Teeth, J. A. D. A., 19:1843 (Oct.) 1932.

17. Mellanby, May: Lancet, 2:767 (Dec. 7) 1918.

18. Howe, P. R.: D. Cosmos, 62:921 (Aug.) 1920; J. A. M. A., 79:1565 (Nov. 4) 1922.

19. McCollum, E. V.; Simmonds, Nina; Kinney, E. M., and Grieves, C. J.: Johns Hopkins Hosp. Bull., 33:202 (June) 1922. Grieves, C. J.: J. A. M. A., 79:1567 (Nov. 4) 1922.

20. Toverud, G.: J. Biol. Chem., 58:583 (Dec.) 1923; Experimental Studies on Physiological and Pathological Chemistry of Teeth, Oslo: Fabritius and Sonners, 1926.

21. Bunting, R. W.: D. Cosmos, 67:771 (Aug.) 1925.

22. Marshall, J. A.: Dental Caries and Pulp Sequelae from Experimental Diets, J. A. D. A., 19:3 (Jan.) 1927.

TABLE 2.—EFFECT OF FEEDING DIETS NORMAL IN CALCIUM AND LOW IN PHOSPHORUS AND VITAMIN D ON THE PRODUCTION OF CARIES*

Rat	Period on Diet Months	Blood Inorganic Phosphorus Mg.	Ash in Bones Per Cent	Macroscopic Caries	Microscopic Caries
1	4.00	—	28.5	+	+
2	4.00	—	—	o	+
3	4.50	—	30.1	+	+
4	6.00	3.7	38.5	+	+
5	4.00	—	24.3	+	+
6	4.00	—	26.3	+	+
7	4.00	—	29.3	+	+
8	4.25	—	43.7	+	+
9	4.5	—	27.2	+	+
10	4.75	1.8	34.0	+	+
11	4.75	2.6	47.3	+	+
12	4.75	—	29.5	+	+
13	4.75	1.5	42.0	+	+
14	3.00	—	22.3	+	+
15	4.25	—	27.1	?	+
16	4.00	—	36.0	+	+
17	4.75	—	32.4	+	+
18	5.00	—	29.4	+	+
19	5.00	—	28.0	+	+
20	6.00	—	29.9	+	?
21	5.75	—	26.1	+	+
22	6.00	—	29.4	+	+
23	2.75	—	—	?	+
24	4.25	—	—	+	+
25	4.25	—	24.1	+	+
26	4.25	—	29.7	+	+
27	4.25	—	35.7	+	+
28	7.50	3.2	40.0	+	+
29	4.25	—	30.3	+	+
30	2.00	—	37.2	+	+
31	2.75	—	37.8	+	+
32	2.75	—	41.8	+	+
33	4.50	—	42.0	+	+
34	4.75	5.6	32.5	+	+
35	4.75	3.5	36.6	+	+
36	6.00	2.4	50.9	+	+

*Rats 1 to 29 were fed on diet 44 (calcium 0.825 per cent and phosphorus 0.260 per cent), and rats 30 to 36, on diet 43 (calcium 0.625 per cent and phosphorus 0.260 per cent).

in fat soluble vitamins. Shibata, in 1929,[23] found that dental caries appeared in rats given a diet of rice and greens with 5 to 10 per cent of various sugars, and this was confirmed by Rosebury[24] in 1932. Hoppert, Webber and Canniff[25]

23. Shibata, M.: Jap. J. Exper. Med., 7:247 (April 10) 1929.

24. Rosebury, T.; Karshan, M., and Foley, G.: J. D. Res., 12:464 (June) 1932.

25. Hoppert, C. A.; Webber, P. A., and Canniff, T. L.: Science, 74:77 (July 17) 1931; J. D. Res., 12:161 (Feb.) 1932.

state that caries appeared in adequately fed rats when the diet was coarsely ground. Klein and McCollum[26] found that a low phosphorus intake increased susceptibility to caries.

Results contrary to those already reviewed were reported by Blackberg and Berke[27] in 1932. They state that when they added extremely large amounts of viosterol to Steenbock's rachitogenic diet (which has a very low phosphorus content), carious lesions developed in young rats after a period of about five months. The amount of viosterol was gradually

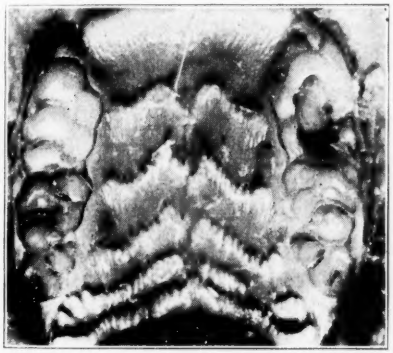

Fig. 3.—Carious molar in upper jaw of rat. There is extensive loss of the occlusal portion of the crown uncomplicated by fracture.

increased until an amount equivalent to about 60 drams of cod liver oil was fed daily. When a diet high in phosphorus was fed, Klein and Shelling[28] found that excessive doses of vitamin D did not cause caries and therefore concluded that ingestion of an excessive amount of this vitamin is not a direct cause of the disease.

26. Klein, Henry, and McCollum, E. V.: Science, 14:662 (Dec. 25) 1931.

27. Blackberg, S. N., and Berke, J. D.: J. D. Res., 12:609 (Aug.) 1932.

28. Klein, Henry, and Shelling, D. H.: J. D. Res., 11:458, 1931.

It is evident that there is marked diversity of opinion as to what is the cause of experimental caries, as a lack of various vitamins, an excess of vitamin D, a deficient supply of the minerals calcium and phosphorus and the consistency of the food have all been considered etiologic factors in the development of this disease.

Studies on the etiology of human caries have been made by Mellanby,[12] Bunting,[13] Jones,[29] Boyd and Drain,[30]

Fig. 4.—Molar teeth of rat (dried lower jaw) free of carious lesions. This rat was fed diet 46, which is normal in calcium and phosphorus but low in vitamin D. The diet of this rat was identical with that used in the case illustrated in Figure 2, with the exception that phosphorus was added. A similar normal appearance was found in those rats in which no evidence of caries was seen when vitamin D was added but the phosphorus kept at the original low level (diet 43-A) (Table 6).

29. Jones, Martha R.; Larson, N. P., and Pritchard, G. P.: D. Cosmos, 72:439 (May), 574 (June), 685 (July) and 797 (Aug.) 1930.

30. Boyd, J. D., and Drain, C. L.: J. A. M. A., 90:1867 (June 9) 1928. Boyd, J. D.; Drain, C. L., and Nelson, M.: Am. J. Dis. Child., 38:721 (Oct.) 1929.

Hanke,[31] Hawkins,[32] Price,[33] McBeath[34] and others. Mellanby is of the opinion that vitamin D either in the form of cod liver oil or viosterol will prevent caries. Bunting emphasizes the importance of *Bacillus acidophilus* in the mouth for the production of caries, but believes that "the diet may affect the hygiene of the mouth and the activity of the aciduric bacteria directly through the character of the retained food materials or indirectly through metabolism and alterations in the salivary secretions." He does not consider that any one factor in the diet is responsible for this action.

Jones found that in children 3 years of age or older, diets containing fruits and vegetables in amounts sufficient to produce an alkaline ash were invariably associated with sound enamel or arrested decay regardless of how the diet was otherwise constituted. Boyd and Drain believe that the tooth integrity may depend on the adequacy of the diet in *all* essential factors. Hanke states that inflammation of the gums and dental caries either disappear or are greatly alleviated when a pint of orange juice and the juice of one lemon are added to the daily diet. Hawkins found that individuals that were immune to dental caries consumed liberal amounts of foods which are high in alkaline ash, in calcium and in vitamin

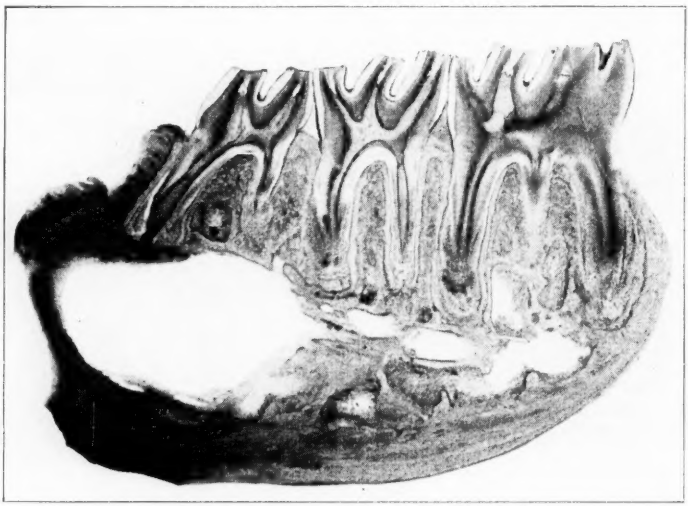

Fig. 5.—Jaw of rat ground mesiodistally showing three molar teeth of one side free of carious defects. There are deep narrow sulci between the cusps and the intact enamel.

31. Hanke, M. T.: Relation of Diet to General Health and Particularly to Inflammation of Oral Tissues and Dental Caries, J. A. D. A., 17:957 (June) 1930; J. Nutrition, 3:433 (Jan.) 1931.

32. Hawkins, H. F.: J. D. Res., 11:201 (April) 1931; What Is Cause of Caries and Systemic Pyorrhea? J.A.D.A., 18:943 (May) 1931.

33. Price, W. A.: Control of Dental Caries and Some Associated Degenerative Processes Through Reinforcement of Diet With Special Activators, J. A. D. A., 19:1339 (Aug.) 1932.

34. McBeth, E. C.: J. D. Res., 12:538 (June) 1932.

D, and low in cereal products. Price believes that dental caries can be largely prevented or controlled by feeding foods sufficiently high in minerals and activators (vitamins). McBeath obtained increased resistance to dental caries by dietary means, but states that "thus far the super importance of any one dietary factor has not been demonstrated."

As with the experimental production of caries in animals, human studies also reveal no unanimity of opinion as to the exact cause of this disease. The majority of investigators believe that diet is of great importance in the prevention of caries.

Two of us (R. G. A. and M. C. A.) attempted the experimental production of caries in rats in China in 1927 under the Rockefeller Foundation by feeding a diet low in vitamin D. In 1930, in the University of Toronto, an extensive program was instituted through a joint effort made by the Department of Paediatrics and one of us (R. G. A.). In approaching the problem of producing dental caries in animals by nutritional means, it was felt advisable to make as few variations in the diet as possible. It is now recognized that there are at least thirty-seven elements necessary for normal nutrition,[35] namely eighteen amino-acids, one fatty acid (linolenic acid), glucose, eleven minerals and six vitamins. While a lack of any of these substances will interfere with the health of the animal as a whole, the close relationship between certain of these elements and definite pathologic conditions is well recognized. For instance, the relation of iodin to the production of goiter, of vitamin C to scurvy, of vitamin D to rickets, and of iron and copper to anemia. It is not unreasonable, therefore, to consider that a limited number of these elements may be intimately connected with the normal nutrition of the tooth, and, conversely, that a lack of these elements may result in the development of certain disease conditions, including caries.

As the tooth is composed to a large extent of calcium and phosphorus, and as it has been established that vitamin D is essential for the optimal utilization of these elements by the body, our attention

TABLE 3.—LACK OF PREVENTIVE EFFECT ON PRODUCTION OF CARIES OF ADDITION OF VITAMINS A, B_1, B_2, C AND E TO DIET 43. (DIET 45 [CALCIUM 0.630 PER CENT AND PHOSPHORUS 0.284 PER CENT].)

Rat	Period on Diet Months	Blood Inorganic Phosphorus Mg.	Ash in Bones Per Cent	Macroscopic Caries	Microscopic Caries
1	2.50	—	38.8	?	+
2	2.50	—	—	+	+
3	7.00	2.2	49.5	+	+
4	2.00	—	48.0	+	+
5	2.00	—	50.3	+	+
6	2.00	—	42.7	+	+
7	2.25	—	—	+	+
8	4.00	—	47.7	+	+

35. McCollum, E. V.: Internat. Clin., 2:1 (June) 1932.

TABLE 4.—EFFECT OF FEEDING DIET LOW IN CALCIUM, PHOSPHORUS AND VITAMIN D ON THE PRODUCTION OF CARIES*

Rat	Period on Diet Months	Blood Inorganic Phosphorus Mg.	Ash in Bones Per Cent	Macroscopic Caries	Microscopic Caries
1	2.50	—	—	+	+
2	2.25	—	—	+	+
3	2.25	—	—	?	+
4	2.25	—	—	+	+
5	2.25	—	39.4	+	—
6	5.00	—	37.6	+	—
7	5.00	—	29.8	+	—
8	5.50	—	32.1	+	+
9	6.00	1.5	46.1	+	+
10	6.00	1.6	42.5	+	+
11	6.00	1.8	31.6	+	+
12	2.00	—	35.5	+	+
13	4.75	1.6	45.9	+	+
14	4.75	2.4	34.1	+	+
15	4.75	3.3	35.5	+	+
16	4.75	2.3	45.9	+	+
17	4.75	3.9	39.9	?	+
18	4.75	3.5	50.0	+	+
19	6.00	—	27.8	+	+
20	4.00	—	49.8	+	+
21	4.00	—	57.8	+	+
22	7.50	1.3	48.4	+	+
23	7.50	2.1	—	+	+
24	7.50	2.2	54.0	+	+
25	7.50	3.0	56.0	+	+
26	2.00	—	—	+	+
27	2.25	—	39.4	+	+
28	2.50	—	31.6	+	+
29	4.50	—	51.8	+	+
30	4.75	4.6	49.7	+	+
31	4.75	3.9	41.1	+	+
32	4.75	3.1	43.5	+	+
33	4.75	—	40.2	+	+
34	4.75	4.8	39.5	+	+
35	2.25	—	—	+	+

*Rats 1 to 25 were fed diet 42 (calcium 0.425 per cent and phosphorus 0.260 per cent); rats 26 to 35, diet 41 (calcium 0.225 per cent and phosphorus 0.260 per cent.)

was directed particularly to these three elements.

The animals chosen for this work were albino and hooded rats. The ease with which large numbers of these animals can be obtained offers advantages, although they are not ideal animals for our purpose for several reasons. For instance, the rat needs very little vitamin C, which is certainly not the case in man. Also, an exclusive diet of milk will not produce rickets in the rat, but frequently does so in the infant; which indicates that a lack of vitamin D has not such serious consequences for the rat as for man. In addition, the teeth in the rat and in man

are not strictly comparable, as the former has no deciduous set. Fortunately, the twelve molars of the rat are sufficiently similar in structure and function to human molars to make them suitable for experimental study. They are of limited growth, possess deep sulci essentially like those found in human molars and are abraded through mastication in a manner similar to the process of attrition in the human being and the pulpal reaction to the invasion of the dentinal tubules closely resembles the reaction of adult human teeth.

Diet 8: Diet normal in calcium and low in phosphorus and vitamin D (calcium content, 0.612 per cent; phosphorus content, 0.240 per cent).

	Per cent
Cornstarch	62.0
Casein (alcohol extracted)	18.0
Crisco (hydrogenated cottonseed oil)	10.0
Yeast (dry powdered)	5.0
Salt mixture (Osborne and Mendel's, without calcium or phosphorus)	2.5
Calcium carbonate	1.5
Sodium chlorid	1.0

Fresh spinach, 100 gm. per animal each week, or machine dried alfalfa, 2 per cent by weight.

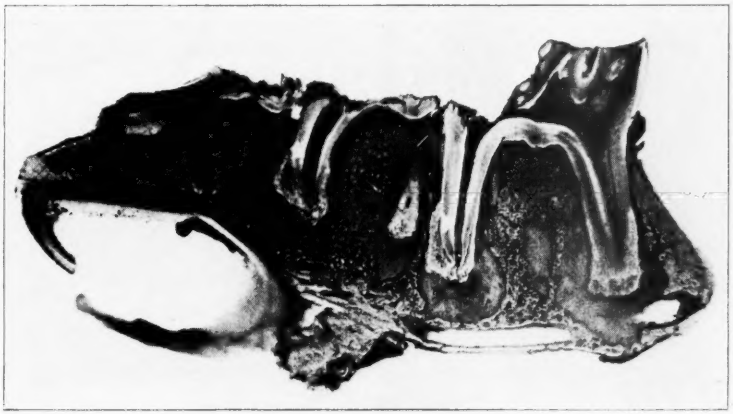

Fig. 6.—Jaw of rat ground mesiodistally showing results of extensive caries with subsequent collapse of coronal portions of teeth.

Diet 1: Normal stock diet (calcium content, 0.793 per cent; phosphorus content, 0.496 per cent).

	Per cent
Whole wheat	60.0
Casein	14.0
Milk powder	10.0
Calcium carbonate	1.2
Sodium chlorid	0.8
Alfalfa	1.0
Butter	8.0
Wheat germ	5.0

Spinach or lettuce, 40 gm. each week per animal; lean meat, 10 gm. each week per animal.

Diet 8-A: Diet 8 with 2 per cent of 1-D viosterol added.

Diet 11-A: Normal diet (calcium content, 0.612 per cent; phosphorus content, 0.450 per cent).

	Per cent
Cornstarch	62.0
Casein (alcohol extracted)	18.0
Crisco (hydrogenated cottonseed oil)	10.0
Yeast (dry powdered)	5.0
Salt mixture (Osborne and Mendel's)	4.0

Sodium chlorid	1.0

To this is added machine dried alfalfa leaf meal, 2 per cent, and 1-D viosterol in corn oil, 2 per cent.

Diet 41: Diet low in calcium, phosphorus and vitamin D (calcium content, 0.225 per cent; phosphorus content, 0.260 per cent).

	Per cent
Whole yellow corn (finely ground)	77.9
Wheat gluten	20.6
Calcium carbonate	0.5
Sodium chlorid	1.0

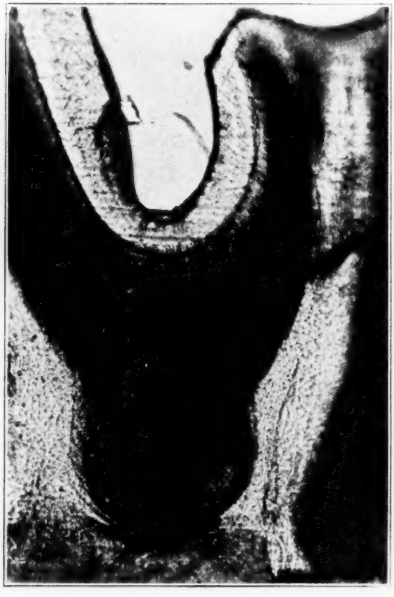

Fig. 7.—Beginning caries of enamel with discoloration in very early stage and unaccompanied as yet by extensive loss of enamel substance.

Diet 42: Diet low in calcium, phosphorus and vitamin D (calcium content, 0.425 per cent; phosphorus content, 0.260 per cent).

	Per cent
Whole yellow corn (finely ground)	77.4
Wheat gluten	20.6
Calcium carbonate	1.0
Sodium chlorid	1.0

Diet 43: Diet normal in calcium (lower limit of normal range) and low in phosphorus and vitamin D (calcium content, 0.625 per cent; phosphorus content, 0.260 per cent).

	Per cent
Whole yellow corn (finely ground)	76.9
Wheat gluten	20.6
Calcium carbonate	1.5
Sodium chlorid	1.0

Diet 43-A: Diet 43 with 2 per cent of 1-D viosterol added.

Fig. 8.—Carious rat molar showing extensive "backward decay" or undermining of enamel. This lesion had commenced at the fundus of the sulcus. A portion of the enamel is in imminent danger of collapse with subsequent wide exposure of dentin.

Diet 44: Diet normal in calcium (upper limit of normal range) and low in phosphorus and vitamin D (calcium content, 0.825 per cent; phosphorus content, 0.260 per cent).

	Per cent
Whole yellow corn (finely ground)	76.4
Wheat gluten	20.6
Calcium carbonate	2.0
Sodium chlorid	1.0

Diet 45: Diet normal in calcium and low in phosphorus and vitamin D, with added vitamins A, B_1, B_2, C and E (calcium content, 0.630 per cent; phosphorus content, 0.284 per cent).

	Per cent
Whole yellow corn (finely ground)	72.5
Wheat gluten	20.0
Calcium carbonate	1.5
Sodium chlorid	1.0
Wheat germ	4.0
Alfalfa (machine dried)	1.0

Tomato juice, 2 c.c. daily per animal.

Diet 45-A: Diet 45 with 2 per cent 1-D viosterol added.

Diet 46: Diet normal in calcium and phosphorus and low in vitamin D (calcium content, 0.625 per cent; posphorus content, 0.483 per cent).

	Per cent
Whole yellow corn (finely ground)	76.0
Wheat gluten	20.0
Calcium carbonate	1.5
Sodium chlorid	1.0
Sodium pyrophosphate $Na_4P_2O_7.10H_2O$	1.5

Diets 1 and 11-A are normal diets. Diet 8 contains protein of high biologic value and plenty of minerals, with the exception of phosphorus. This diet is also low in vitamin D. In Diet 8-A, the deficiency of vitamin D was corrected. Diets 41, 42, 43, 43-A, 44, 45, 45-A and 46 are modifications of Steenbock's rachitogenic diet,[36] which does not contain an optimal quantity of minerals and vitamins, and whose proteins are not of high biologic value. Variations were made in this basic diet by a change in the concentration of calcium and phosphorus and by the addition of machine-dried alfalfa leaf meal, wheat germ and tomato juice. The last three materials add vitamins A, B_1, B_2, C and E and minerals to the diet.

Whole grains obtained from the milling companies and then ground in the laboratory were used. This is important because, from experience, we have found that one is not certain of receiving whole grains if they are ground by the milling companies. All diets were finally ground three times in a "Hobart" mill and care

TABLE 5.—EFFECT ON PRODUCTION OF CARIES OF ADDING PHOSPHORUS TO DIET LOW IN PHOSPHORUS AND VITAMIN D (DIET 43). (DIET 46 [CALCIUM 0.625 PER CENT AND PHOSPHORUS 0.483 PER CENT].)

Rat	Period on Diet Months	Blood Inorganic Phosphorus Mg.	Ash in Bones Per Cent	Macroscopic Caries	Microscopic Caries
1	2.75	—	49.8	o	o
2	6.00	1.6	54.6	o	o
3	6.00	3.1	56.6	?	+
4	6.00	3.4	55.6	o	o
5	6.00	2.6	56.2	o	+
6	6.00	3.3	—	o	—
7	6.00	2.2	48.5	o	?
8	5.50	—	—	o	o

36. Steenbock, H., and Black, A.: J. Biol. Chem., 64:263 (June) 1925.

was taken to insure adequate mixing of the different ingredients. The 1-D viosterol has a vitamin D potency equivalent to that of Steenbock's standard cod liver oil. It was added in the proper proportions to a quantity of the diet sufficient to last only two or three days in order to avoid possible loss through oxidation, which might occur if it were added to a large quantity of the diet and allowed to stand for a long period. The animals were placed on the experimental diets at 4 weeks of age and were kept in roomy cages which had coarse wire mesh bottoms. Any food that was spilt from the food cups was collected and weighed in order to keep the food records as accurately as possible. No cod liver oil was added to the stock diet of the breeding rats, as it is well recognized that this produces a vitamin D effect in the young which lasts for some time.

TABLE 6.—EFFECT ON PRODUCTION OF CARIES OF ADDING VITAMIN D TO DIET LOW IN PHOSPHORUS AND VITAMIN D (DIET 43). (DIET 43-A [CALCIUM 0.625 PER CENT AND PHOSPHORUS 0.260 PER CENT]; DURATION OF DIET, 2 TO 5 MONTHS.)

Rat	Period on Diet Months	Ash in Bone Per Cent	Macroscopic Caries	Microscopic Caries
1	2.5	42.4	o	o
2	3.0	—	?	o
3	2.5	41.2	o	o
4	3.0	—	o	o
5	5.0	—	o	o
6	5.0	—	o	o
7	3.5	54.0	?	+
8	3.5	55.4	?	+
9	4.5	51.2	+	+
10	3.0	46.5	+	+
11	3.0	—	o	+
12	3.5	54.3	o	+
13	4.5	58.5	+	+
14	3.0	49.4	+	+
15	2.5	49.6	+	+
16	3.5	56.1	?	+
17	4.0	49.0	?	+
18	4.5	—	o	+
19	3.5	—	+	+
Total 19				
Average age	3.5			

After the animals had been fed the diets for stated intervals, they were anesthetized with ether and, in some instances, blood was taken for the determination of the inorganic phosphorus in the whole blood by the method of Fiske and Subbarow.[37] The percentage of ash in the fat-free tibia and fibula was also determined, using the Bethke, Steenbock and Nelson technic.[38]

A study of the oral tissues of the animals was made, following three general procedures: (1) gross study of the teeth and jaws with the aid of the binocular dissecting microscope; (2) study of ground undecalcified sections, stained and unstained, of the teeth and the alveolar bone, including the imbedding method (kollolith or balsam, which retain the soft tissues *in situ);* (3) study of decalcified and serially mounted sections using a variety of stains for tissue or bacterial demonstration.

MACROSCOPIC EXAMINATION

Gross examination revealed lesions of the enamel and dentin (and pulp) which exhibited the characteristics macroscopically of dental caries as seen in the human being. The lesions occurred almost invariably on the occlusal surface, commencing at or near the fundus of the sulci of the crowns. In some cases, the external lesion was small. In others,

37. Fiske, C. H., and Subbarow, Y.: J. Biol. Chem., 66:375 (Dec.) 1925.

38. Bethke, R. M.; Steenbock, H., and Nelson, M. T.: J. Biol. Chem., 58:71 (Nov.) 1923.

there was found extensive destruction of a part or of the whole of the crown, exposing the floor of the pulp chamber and the orifices of the root canals. In some instances, weakening of the tooth wall had led to collapse of portions of the crown. Examples of macroscopic caries are shown in Figures 2 and 3, with contrasting normal conditions in Figures 1 and 4.

Fig. 9.—Ground section of rat molar showing in fundus of sulcus invasion of enamel and involvement of dentin with production of defensive "translucent zone" in dentin, appearing as light band. There is a deep sulcus filled with débris; also, on the extreme lower left, a similar lesion affecting the cervical portion of the tooth.

MICROSCOPIC EXAMINATIONS

Ground Sections.—Ground sections again revealed the characteristic phenomena seen in human dental caries. The areas of affected enamel corresponded in location and contour with the areas of affected enamel in human caries where pits, fissures and sulci are attacked. The contours were largely cone shaped, with the base directed toward the pulp and the apex toward the surface of the tooth. Discoloration of the affected enamel corresponded to discoloration of involved enamel in human teeth. Following the penetration of the carious process to the amelodentinal border, secondary caries of enamel, or "backward decay of enamel," was found to occur. This phenomenon, consisting of a lateral spread of the carious process immediately beneath the enamel, commencing at the point of invasion of the dentin, is due largely to the abundant anastomoses of the peripheral ends of the dentinal tubules facilitating the spread of the lesion.

As a result of this condition, not only is the dentin attacked over a wider area leading to shallow mass collapse of the dentin, but likewise the enamel is attacked from the inner side. Thus, as in the human being, the actual size of the involved area may be considerable, while prior to the collapse of the weakened and overhanging enamel, the external opening may be minute. In the ground section, moreover, may be seen the phenomenon known as the "zone of translucency," commonly seen in molar occlusal caries in the human being. This is a defensive reaction consisting of a hypercalcification occurring in the involved dentinal tubules, the purpose of which is to protect the proximal dentin and the pulp. Figures 6 to 9 illustrate ground sections of carious rat molars. Figure 5 illustrates a caries-free jaw for comparison.

Decalcified Sections.—Decalcified sections afforded much further information regarding the processes involved. Since the organic portion of enamel is relatively small (approximately 3 per cent),

the action of the acids which are formed in the carious process is sufficient to disintegrate the enamel. Similarly, in laboratory decalcification, the enamel is in large part disintegrated and lost unless special imbedding processes are employed to maintain *in situ* the delicate organic matrix.

In the case of the dentin, the high percentage of organic material present (approximately 28 per cent) maintains the original form and structure even after decalcification. Disintegration and dissolution of the dentin in the carious process are secondarily brought about through peptonization, accomplished by certain proteolytic types of organisms. Naturally, therefore, laboratory decalcification in the preparation of the specimens for microscopic examination reveals further evidence of the structural changes which occur.

In dentinal caries, the matrix is usually decalcified before the tubules are invaded by bacteria. The sheath of Neumann, which forms the immediate wall of the tubule, becomes thickened, and there is an actual increase in the diameter of the tubule. The softened matrix between the tubules is compressed and with peptonization of this matrix and increase in tubular diameter, these tubules may come into contact. These enlarged and prominent "pipe-stem tubules" are readily observed in the sections.

Micro-organisms invade the tubules and bring about the disintegration of the sheaths of Neumann; which brings neighboring tubules into intimate relationship. The term "liquefaction foci" is applied to broadened zones along the course of the tubules where the intervening walls have been broken down.

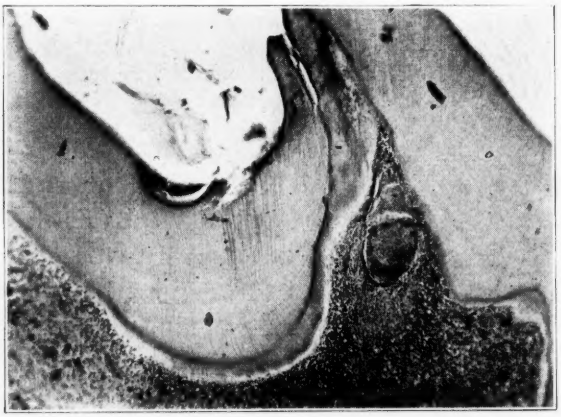

Fig. 10.—Early carious lesion in dentin of rat molar (decalcified section). The attack has commenced at the fundus of the sulcus. Superficial mass collapse of the dentin and the small number of engorged "pipestem tubules" with bulbous enlargements may be noted.

With the increase in size of these "liquefaction foci" and coalescence of neighboring foci, there occurs the gradual production of a cavity in which may be found detritus of dentinal origin with bacteria, etc. Where the "backward decay of enamel" has been extensive, and broad areas of dentin become involved, the contour of the carious area is roughly

that of a cone with the apex directed toward the pulp.

A barrier of variable effectiveness is often thrown up by the pulp. This overlies the pulpal extremities of the affected dentinal tubules in the so-called "dead tracts"[39]; i.e., the area of involved dentin in which hypercalcification has not taken place, and this secondary dentin attempts to protect the pulp tissue from peripheral injuries sustained by the primary dentin by means of a nontubular barrier. (Simple extension of primary dentin does not show this barrier.)

exhibited evidence of carious lesions. The possibility of the production of caries-like lesions through splitting of the cusps of rat molars or other trauma, with resultant "holes" of noncarious origin, is eliminated by the careful histologic examination. Such splitting of cusps may be observed to a certain extent in both control and experimental animals, but, in the control animals, has in no case been associated with dental caries.

COMMENT

The caries which occurred in these

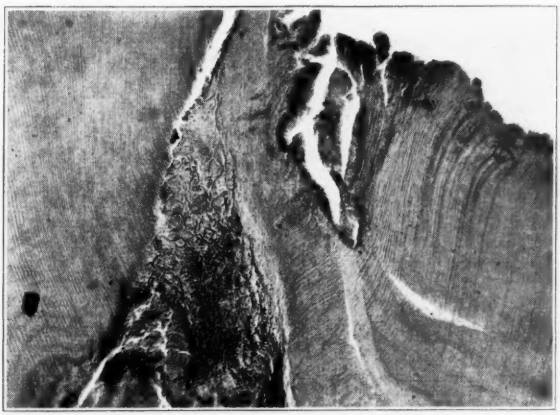

Fig. 11.—Advanced stage of caries of dentin in rat molar. There are grossly enlarged "pipestem tubules" and, particularly in the central portion of the picture, extensive coalescence of "liquefaction foci" with collapse of dentin may be seen. The barrier of secondary dentin below the latter area temporarily retards the process. The similarity to the human condition pictured in Figure 12 may be noted.

Figures 10 to 13 are serial sections of decalcified carious teeth showing the process above described. Figure 12 illustrates a case of human dentinal caries which shows the similarity to that of the rat.

Control animals have in no instance

rats is essentially comparable to that found in man. When the animals were fed the normal stock diet 1, or the normal diet 11-A, caries was never found, even after a period of eighteen months. In contrast to this, the animals which were given a diet composed of yellow corn, wheat gluten, calcium carbonate and sodium chlorid, a diet which is very low in phosphorus and vitamin

39. Fish, E. W.: Experimental Investigation of Enamel, Dentine and Dental Pulp, London: John Bale Sons and Danielsson, 1932.

D, for two months or more, developed caries in almost every instance. The addition of vitamins A, B_1, B_2, C and E to this diet apparently did not influence in any way the development of caries.

As this diet is also deficient in minerals and high quality proteins, one could not conclude from these experiments that the caries was due entirely to the low phosphorus content and the absence of vitamin D. When the phosphorus level of this diet was brought up to the so-called normal level, caries was prevented in four out of seven animals for periods up to six months. Also, when the phosphorus was left at the original low level, the addition of vitamin D reduced the prevalence of caries, as six of a series of nineteen animals did not develop the disease in periods up to five months.

Fig. 12.—Caries of dentin in human tooth showing "pipestem tubules," coalescing "liquefaction foci" and extensive superficial destruction of dentin. Similarity to the condition shown in Figure 11 may be noted.

On examination, only 50 per cent of the animals fed diet 8, which, although low in phosphorus and vitamin D is quite adequate in both proteins and other minerals, showed caries during periods up to thirteen months. When vitamin D was added to this diet, caries did not develop in a single instance during similar periods.

Fig. 13.—Carious process in rat molar penetrating secondary dentin barrier and leading to necrosis of adjacent pulp tissue. There is extensive surface loss of dentin. Infected tubules leading from the periphery of the dentin at a further point in the serial are seen to penetrate the secondary dentin along the pulpal wall, causing invasion of the pulp.

Calcium was added in varying amounts to give percentages varying

from the high normal level of 0.825 per cent to the very low level of 0.225 per cent, but this had no apparent influence on the development of caries.

Other investigations carried on in this laboratory by Dr. Chant Robertson and her co-workers indicate that when the proteins are not of a high grade, or when certain of the vitamins are absent, the resistance to infection and the general health of the animal are impaired. It is quite reasonable, therefore, to consider that the maintenance of normal teeth is dependent primarily on a sufficient supply of phosphorus and vitamin D, but that any other deficiency in the diet which impairs the general health of the animal would accentuate the effect of inadequacy in the supply of phosphorus and vitamin D. It is quite possible, of course, that the consistency of the food might also be a factor in the production of caries in these animals, because the corn diets impacted much more readily than did diet 8. It should be noted that when an adequate amount of phosphorus or vitamin D was added to the diet, which did not alter its consistency in the slightest degree, the development of caries was prevented or delayed.

No relation is evident between the percentage of bone ash and the incidence of caries. The whole blood inorganic phosphorus was low in the animals that developed caries. The blood phosphorus of the animals on the normal stock diet 1 and the normal diet 11-A was usually above 5.0 mg. per hundred cubic centimeters of blood. In the older animals, it was sometimes as low as 4.0 mg. and occasionally it even went down to 3.5 mg. A rather unexpected result was seen in the animals receiving added phosphorus (Table 5), which, although they did not develop caries, still showed a low blood phosphorus. The same low blood phosphorus was found in the ani-

TABLE 7.—EFFECT ON PRODUCTION OF CARIES OF ADDING VITAMIN D TO DIET LOW IN PHOSPHORUS AND VITAMIN D (DIET 43). (DIET 43-A [CALCIUM 0.625 PER CENT AND PHOSPHORUS 0.260 PER CENT]; DURATION OF DIET, OVER 5 MONTHS.)

Rat	Period on Diet Months	Blood Inorganic Phosphorus Mg.	Ash in Bones Per Cent	Macroscopic Caries	Microscopic Caries
1	6.5	2.9	55.8	+	+
2	6.5	3.5	55.4	+	—
3	6.5	3.4	55.7	+	—
4	6.5	—	43.8	+	+
5	6.5	—	55.9	+	—
6	7.5	3.0	58.1	+	+
7	7.5	3.6	58.4	+	+
8	7.5	3.3	59.1	+	+
9	8.0	3.3	—	+	+
10	8.0	3.7	—	+	+
11	8.0	3.7	—	+	—
12	8.0	3.8	—	+	—
13	8.0	4.1	—	+	—
14	8.0	3.5	—	+	—
15	8.0	3.5	—	+	—

mals that were given vitamin D in addition to this diet. Further work will be undertaken on this aspect of the problem.

From our results, it is reasonable to conclude that, in the rat, adequate supplies of phosphorus and vitamin D are factors in the prevention of dental caries. This is essentially in accord with the views expressed by McCollum and his co-workers,[39] who stressed the possible importance of these elements as long ago as 1922. In the rat, it is evident that, of these two elements, the phosphorus is the more important. This is also true in the experimental production of rickets, as this disease cannot be produced in the rat when phosphorus is added to a rachitogenic diet, in spite of a low vitamin D intake. In infants, it is universally recognized that vitamin D is essential for the prevention of rickets in spite of a large phosphorus intake. It is reasonable

TABLE 8.—EFFECT ON PRODUCTION OF CARIES OF FEEDING DIET NORMAL IN CALCIUM AND LOW IN PHOSPHORUS AND VITAMIN D. (DIET 8 [CALCIUM 0.612 PER CENT AND PHOSPHORUS 0.240 PER CENT]).

Rat	Period on Diet Months	Blood Inorganic Phosphorus Mg.	Ash in Bones Per Cent	Macroscopic Caries	Microscopic Caries
1	5.5	—	53.5	o	+
2	9.5	—	58.7	o	+
3	9.5	—	—	o	?
4	9.5	—	—	o	+
5	6.0	3.0	56.2	o	+
6	6.0	—	55.8	o	o
7	9.5	—	56.1	o	+
8	13.0	2.6	59.0	o	?
9	13.0	—	56.6	o	o
10	6.0	—	—	o	o

TABLE 9.—EFFECT ON PRODUCTION OF CARIES OF ADDING VITAMIN D TO DIET LOW IN PHOSPHORUS AND VITAMIN D (DIET 8). (DIET 8-A [CALCIUM 0.612 PER CENT AND PHOSPHORUS 0.240 PER CENT]).

Rat	Period on Diet Months	Blood Inorganic Phosphorus Mg.	Ash in Bones Per Cent	Macroscopic Caries	Microscopic Caries
1	6	5.0	58.6	o	o
2	13	4.4	59.8	o	o
3	13	4.4	59.7	o	o
4	13	3.9	62.1	o	o
5	10	—	—	o	o
6	8	—	—	o	o
7	8	—	—	o	o
8	8	—	—	o	o
9	8	4.7	59.7	o	o

39. Footnotes 19 and 26.

to expect, therefore, that, in view of the prevalence of caries in individuals who are consuming diets which contain fairly large amounts of phosphorus, the vitamin D factor is of greater importance for the prevention of caries in the human being than it is in the rat.

It is realized fully that the value of this work lies in its application to man. Accordingly, a total of approximately 350 children on diets containing varying amounts of calcium, phosphorus and vitamin D have been observed during the past year in four institutions with the aid of a group of dentists of Toronto. A most meticulous dental examination was carried out at the beginning of the investigation and will be repeated at its conclusion. During the period of the investigation, the children have been divided into three groups as follows: (1) the control group, in which no change has been made in the diet; (2) a group who have been given additional vitamin D, and (3) a group who have been given both additional vitamin D and phosphorus.

An interim examination has recently been made of the children in groups 1 and 2. To insure an unbiased interpretation of results, operators in examining the children were unaware of the groups in which the children were classified until all the records were completed. This examination showed, in those children who had been given additional vitamin D, a definite trend toward a lessened incidence of caries as compared to those who had eaten only the usual normal diet. Moreover, the children with added vitamin D showed that previously existing cavities had been largely arrested. In certain of these arrested cases, a definite hardening of the cavity walls was apparent. The general tone of the gingivae and of the mucous membrane of the mouth of these children showed a definite improvement when compared with the gingivae and mucous membrane of those children who had not been given the additional supply of vitamin D.

SUMMARY

1. No evidence of dental caries was found in 365 animals fed the normal diets for periods of from two to eighteen months.

2. Seventy out of seventy-one animals fed a diet low in phosphorus and vitamin D for periods of from two to seven months showed dental caries. This diet, composed largely of corn and wheat gluten, is also low in other minerals and vitamins, and the proteins are not of a good quality.

3. The addition of vitamins A, B_1, B_2, C and E to this diet apparently did not have any effect on the development of dental caries.

4. The addition of phosphorus to this diet prevented the development of dental caries in four out of seven rats when fed for periods of from two and three-quarters to six months.

5. The addition of vitamin D to this diet in the form of viosterol prevented the development of dental caries in six out of nineteen rats when fed for periods of two and one-half to five months.

6. Ten animals were fed a diet composed of cornstarch, casein, vegetable fat (crisco) and yeast, with added minerals and vitamins for periods of from five and one-half to thirteen months. This diet, although low in phosphorus and vitamin D, is adequate in other respects. Dental caries developed in five of these animals.

7. Nine animals fed this diet with the addition of vitamin D in the form of viosterol for periods of from six to thirteen months did not show evidences of dental caries in any instance.

8. The amount of calcium in the diet apparently had no influence on the development of dental caries.

9. A preliminary examination of a number of children under observation indicates the importance of an adequate supply of vitamin D for the prevention of dental caries.

CONCLUSIONS

1. Dental caries can be produced and prevented in laboratory animals at will by dietary means.

2. In the rat, an adequate supply of phosphorus is an important factor in the prevention of dental caries.

3. In the rat, an adequate supply of vitamin D may prevent or delay the onset of dental caries. In this animal, the role of vitamin D is not of such great importance as that of phosphorus.

4. In man, the addition of vitamin D to diets previously considered adequate in all respects, including phosphorus intake, is an important factor in the prevention of dental caries.

AN APPLICATION OF RECENT DEVELOPMENTS IN INLAY CASTING*

By HERBERT D. COY, D.D.S., Hamburg, Iowa

IT is my object to show that accurately fitting inlays can be made by every dentist, with a minimum of expense and equipment, if he will but apply the facts regarding inlay casting materials and technic established by the research work of the National Bureau of Standards, and the Research Commission of the American Dental Association and its cooperative committee of practicing dentists, with whom it has been my privilege to be associated.

RESEARCH

To discuss adequately the value of the work accomplished in the time allotted to me is an impossible task. Reports on the progress of the work have gone out at intervals, to be received with much interest in many quarters. It is to be deplored that comparatively few of the profession have either read or applied these facts.

Tentative specifications have been prepared by the Bureau of Standards and the American Dental Association Research Commission for amalgams, inlay casting waxes, inlay casting investments, impression compounds and inlay casting golds.

Any material that conforms to these specifications as a minimum requirement can be relied on to possess constant physical qualifications. The requirement that the thermal expansion curve of each brand of inlay investment and inlay wax, together with other valuable information, be printed plainly by the manufacturer on each package sold has been one of the most valuable contributions of this research, surmounting the value to be gained from the knowledge acquired by

*Read before the Section on Operative Dentistry, Materia Medica and Therapeutics at the Seventy-Fourth Annual Session of the American Dental Association, Buffalo, N. Y., Sept. 13, 1932.

those who have clinically tested the results obtained by the Bureau of Standards.

VARIABLES

The three principal variables with which we are confronted, in our efforts toward accurate castings are: (1) gold, (2) inlay casting waxes and (3) inlay casting investments. The problem of casting an accurate gold inlay can be solved only when the physical properties of the materials entering into the process are known and utilized.

GOLD

The shrinkage of gold has been found to be approximately 1.25 per cent. While there is some evidence that this figure may vary slightly in the different types of gold, the variation is small and, for practical castings, may be disregarded.

The shrinkage of gold is the greatest variable in the casting process. This deficiency must be balanced as one of the important steps in the production of an accurate casting. Extensive experiments have proved that the shrinkage of gold is practically constant when the temperature varies from the lowest at which it can be cast to the maximum obtainable with a good blowpipe, using hydrogen and compressed air.

An expanded mold may be assured by submitting the invested wax pattern to a rise in temperature in a water-bath before the initial set takes place, by utilizing the setting and thermal expansion of the investment or by a combination of wax and investment expansion.

Of all the methods of obtaining expansion of the mold, investment expansion seems to present fewer complications.

INLAY WAXES

Of all the variables entering in the problems in casting to dimension, inlay wax is perhaps the most difficult to control and understand.

Inlay waxes change form whenever subjected to change in temperature. This volume change may develop into a distortion under improper manipulation and handling. A distorted pattern can never be made into an accurately fitting inlay.

If room temperature remained at a constant point in every office throughout the entire year, the volume change of wax due to temperature change would not be a great problem. In the various localities of the United States, it is possible to have variations in room temperature from 70 to 115 F.

If we accept 95 F. as the average temperature of a wax pattern in the mouth, this must be the starting point for any volume change that may occur when the pattern is removed from the mouth and submitted to room temperature.

Inlay waxes that meet the specifications of the American Dental Association have a definite volume change for each degree of temperature change. The same results would not be obtained by investing a pattern made at mouth temperature (95 F.) at a room temperature of 70 F. as would be obtained by investing it at a room temperature of 115 F. Therefore, if uniform results are to be had, uniform temperatures must be maintained at and during the time of investing.

INLAY INVESTMENTS

The inlay casting investments that meet the specifications of the American Dental Association are of high-silica and low-plaster content, the ratio being about 4 parts silica to 1 part plaster of Paris.

These investments have a consistent and progressive expansion when heated, reaching their maximum expansion at approximately 1300 F.

To achieve the same results each time,

it is necessary for the dentist to know the physical characteristics of the investment that he is using. He must also be able to apply the knowledge intelligently, so that the proper compensation may be made, and is always under the control of the operator.

Several investments now on the market meet the specifications of the American Dental Association. Any of these may be depended on to produce uniform results, if used in a manner that will make their desirable characteristics available.

CAVITY PREPARATION

G. V. Black gave his principles of cavity preparation to the dental profession ten years before the cast gold inlay came into common use. Those principles, with the slight modifications necessary to make them applicable to inlay cavities, are still recognized by authorities as in every way meeting the needs of modern dentistry.

WAX PATTERN

Direct Method.—The making of a true wax pattern of a cavity requires painstaking effort on the part of the operator. The tendency of wax to distortion, owing to careless instrumentation during carving, is great. Extreme care should be taken during this procedure to avoid complicating an already intricate process.

An inlay wax should be selected whose physical properties are known to the operator and one that conforms to the specifications of the American Dental Association.

The use of a confining matrix is usually necessary in compound cavities. If a matrix is used, it should be so adapted that it will permit the flow of wax over the cavity margins, especially the gingival margin. It should be so shaped that it will permit the closing of the teeth in centric relationship, and should be one that can be easily removed without distorting the pattern.

When the rubber dam is used, the cavity is lubricated with tincture of green soap. Saliva provides an excellent lubricant when the rubber dam is not used. The wax may be softened in warm water or over an open flame, then molded into a shape which will make it easily adaptable to the cavity.

The wax is forced into the cavity and held under pressure until sufficient time has elapsed for it to return to mouth temperature; usually, about three or four minutes.

Since wax has a volume change when subjected to temperature change, it is essential that when placed in a cavity in the mouth, it should not be chilled by the use of cold water or air.

The occluding surface of the wax may then be slightly heated with a pledget of cotton dipped in hot water, and the teeth brought together in occlusion. The occlusal portion of the pattern, in posterior teeth where a matrix is used, should be carved to form before removal of the matrix.

The matrix is then removed and the remaining portion of the pattern carved to form. The proximal surface of the pattern should be polished with silk tape and the other surfaces should be smoothed and polished with a cotton pellet moistened in mouth-temperature water. A wax solvent should not be used for smoothing the surface.

The occlusion cannot be registered when the rubber dam is used. With it in place, the pattern is carved to form as accurately as possible, and the final adjustment of occlusion is made after the casting is completed.

Whenever possible, the sprue is attached and the completed pattern is removed from the cavity by force gently

applied, rather than by an instrument, such as an explorer.

The size of the sprue depends on the casting to be made, but it should be the same diameter throughout its entire length, one from 13 to 18 gage having been found most satisfactory.

The sprue should be attached in the center of the pattern so that all parts of the mold will be an equal distance from the point of distribution of the gold.

It should also be attached so that all parts of the pattern will be away from the point of attachment and thus the gold will not have to flow up hill to fill the mold.

After the pattern is removed from the cavity, it should be washed with a solution of equal parts of tincture of green soap and hydrogen peroxid, rinsed with room temperature water and dried with a slight application of air from a syringe. The pattern is now ready for investing.

Indirect Method.—For those who prefer the indirect method of obtaining the wax pattern, the following outline is presented:

A 36-gage copper band matrix is trimmed to fit over the contact point and just beyond the bell of the tooth, except on the cavity side, where it must extend beyond the gingival margin.

Impression: A modeling compound is used which meets the specifications of the American Dental Association. After the fingers have been moistened with water, a cone about the size of the tooth is formed.

With the copper band in place on the tooth, the tip of the compound cone is heated in an open flame, and then the cone is forced into the copper band surrounding the cavity, being held under pressure until sufficient time has elapsed for it to assume mouth temperature. This takes place in three or four minutes. We do not chill the compound with cold water or air, as it may cause distortion. The compound impression may be removed and examined at this time. An inlay wax impression is now made registering the occlusion and contact with the other teeth. This can be roughly trimmed to shape and laid away for later use.

Amalgam die: A strip of gummed paper is wrapped around the copper band, so that it will extend about one quarter inch from the impression. Investment is made in plaster of Paris in a rubber ring, the impression being submerged in the plaster to the top of the paper. A slow setting plaster, with no potassium added, is used so that there will be no heating in setting. After the plaster has set, the model is ready to be made.

Silver amalgam which meets the specifications of the American Dental Association is used. This type of amalgam has practically no setting expansion or contraction if packed densely. As a "sloppy" mix of amalgam has a large amount of volume change in setting, amalgam for models should be packed densely and all possible mercury expressed.

Sufficient amalgam is thoroughly mixed with a mortar and pestle. The mix is divided, mercury being added to one portion to make a sloppy mix. This is vibrated into the impression. When the cavity portion is covered, some of the dry mix is added, expressing the mercury, and it is then packed with an orangewood stick. The dry mix of amalgam is continued, and it is packed until no more mercury is brought to the top. For final condensation, a large stick and a mallet are used. The amalgam is now allowed to set for at least two hours before separating.

The plaster is then removed from around the band, and the compound softened in warm water and removed from the amalgam die. The die is lubricated

with thin oil, and the wax impression previously taken from the cavity in the mouth is placed in the model. With a hot spatula, the margins of the cavity are traced around, the wax being forced into close contact with the cavity walls as it begins to cool, care being used not to destroy the impression of the contact or occlusion.

The pattern is then carved to form and invested as for a direct inlay.

If the technic described is carefully followed, the only difficulty will be the shrinkage of the modeling compound impression from mouth temperature to room temperature, which is usually about 0.4 per cent in a room temperature of 70 F. This can be balanced by subjecting the invested pattern to a water-bath at 95 F.

The making of a gold inlay, using the indirect method for obtaining the wax pattern, presents some problems not present under the direct method. As in inlay waxes, modeling compounds change form when subjected to change in temperature. The amount of shrinkage in a modeling compound impression removed from a cavity in the mouth depends on the room temperature and the kind of compound used. This shrinkage must be balanced, if an accurately fitting inlay is to be produced. Also, many of the alloys used for models either shrink or expand on setting.

If the variables can be determined and controlled by the operator, casting to dimension can be accomplished quite as well as with the direct method, but it is recommended that the indirect method be used only when the direct seems impractical.

Investing: A piece of sheet asbestos is cut one sixteenth inch thick, and the entire inner surface of the ring lined with it. A new lining must be used for each pattern invested. One end of the ring is then sealed to a small metal slab with beeswax. The asbestos lining should be previously moistened with water so that the water content of the investment will not be changed when poured into the ring.

The asbestos lining in the ring provides an expansion cushion which permits the setting expansion to take place toward the circumference of the ring instead of inward toward the pattern, which would result in a distortion.

The asbestos lining would be unnecessary if a double investment method were used and the first investment, surrounding the pattern, allowed to set unconfined by a ring.

Many investments are now available which meet the tentative specifications of the American Dental Association.

The amount of setting and thermal expansion in ratio to the amount of water necessary for the mix must be determined, and is usually indicated on the package by the manufacturer.

The consistency of the mix has a direct relationship to the setting and the thermal expansion. Therefore, the water and investment should be accurately weighed on a set of gram scales.

The water and investment are placed in a clean, dry mixing bowl, and first spatulated by hand, then by a mechanical spatulator, for about 300 turns of the blade, which is about 100 turns of the handle for most of spatulators now available. About thirty seconds is allowed for spatulation, if a power mixer is used. Thorough mixing is necessary and important, as a well-beaten investment will be productive of more expansion and a smoother finish to the casting.

The ring is vibrated full of investment, more of which is formed on the pattern, with a camel's hair brush, care being taken not to trap any air between the investment and the pattern. The pattern on the sprue, and fastened in the sprue

former base, is now gently vibrated into the investment filled ring until the base is seated. A clamp is adjusted to hold the base and ring securely together. The invested ring is now placed in a water bath, the temperature of which is maintained at 95 F., until the investment has set.

A wax pattern changes size when subjected to a change in temperature. Therefore, if it is to be exactly the same size when invested as when removed from the cavity, it must be returned to mouth temperature in a water-bath. If it is desirable to increase or decrease the size of the casting to be made, the temperature of the water-bath may be regulated accordingly, the operator keeping in mind that an increase in temperature expands the wax pattern, and a decrease in temperature contracts it. The amount of this change which occurs between two temperature ranges can be readily determined by referring to the wax expansion curve, which is furnished by most of the manufacturers.

The invested pattern is allowed to remain in the water bath until the investment has set. The setting time, which varies according to the investment used, is usually indicated on the container.

WATER-BATH

As previously stated, marked fluctuations in room temperature will produce variations in the size of the finished casting, owing to the property in wax which causes it to expand when heated and contract when chilled. Therefore, if positive and consistent results are to be gained, the temperature at which the wax pattern is invested must be under control.

A water-bath in which the invested pattern may be submerged is the most desirable means of obtaining and maintaining temperatures which are under control of the operator. It makes it possible to invest at the same temperature each time, which, in turn, means investing the same sized pattern each time.

A water-bath should contain enough volume of water to make it easy to maintain a desired temperature. A heavy aluminum cooking utensil with a capacity of 3 or 4 quarts of water makes a very satisfactory water bath. A hole may be made through the lid to accommodate a floating dairy thermometer.

ELIMINATION

After the investment has set, the metal slab, the sprue former base and the sprue pin are removed. The invested pattern is placed in a furnace for fifteen minutes at a temperature of approximately 500 F. The heat is raised to 900 F. for fifteen minutes. It is then raised to 1300 F., this point being determined when a dull red is visible through the sprue hole. The casting should be made at this temperature, as the investment reaches its maximum expansion at that heat and begins to contract at a temperature slightly above 1300 F.

An open flame may be used for the elimination, if a furnace is not available, although the furnace is much to be desired, for accuracy and convenience. If an open flame is used, the elimination should be started on a very low flame, being gradually increased until a dull red is visible through the sprue hole.

It is important that the first or low heat should not be sufficiently high to boil the water from the investment. It should be considered a drying heat, with which the moisture is eliminated very slowly. To burn out too rapidly is likely to produce a rough casting.

CASTING

The style and type of casting machine to be used is largely a matter of individual

choice as long as one is selected that will force the gold to place. Loss of heat will cause the mold to shrink. Therefore, the casting should be made immediately after the ring is removed from the furnace.

The gold for the casting should be selected according to the needs of the individual case. The specifications of the American Dental Association divide golds for inlay casting into three groups: Group A, a soft gold, should be used where the stress is light. It can be easily burnished. Group B, a medium hard gold, is indicated in cases of moderate stress. Group C, a hard gold, is indicated in cases subject to high stress, such as three-quarter crowns, thin cast backings, full crowns, pontics and saddles.

No doubt, new developments will arise which will further simplify the casting process. It is predicted that the work of the National Bureau of Standards and the Research Commission of the American Dental Association will prove to be one of the outstanding achievements in dentistry in our generation and will furnish a basis for all future progress in the field of casting.

DISCUSSION

A. F. Schopper, Kansas City, Mo.: Dr. Coy has labored long and diligently in the developing of this technic and has presented the details in their entirety in his manuscript. In my opinion, more has been accomplished in the last five years by the general practitioner in producing accurately fitting cast gold inlays than in the previous twenty-five years of our profession. The surface might be scratched, but there is much yet to be done. We are, I believe, all convinced that until such time as we can control the expansion and contraction of the so-called inlay wax as furnished by the manufacturer today, or we are given some material or combination of materials that will be devoid of the erratic behavior of wax, the perfect cast gold inlay will be only a theory. As to cavity preparation, I would take exception to Dr. Coy's statement that Dr. Black's cavity preparation with slight modifications is all that is necessary in our inlay work of today. It is the consensus of opinion that it requires more than "slight modifications" to obtain a form that will permit withdrawal of the wax in most of our preparations as they are nearly always compound and complex. The employment of various gold alloys and the use of pins in vital teeth have also contributed to this change. Under the heading "Indirect Method" there might have been added the direct-indirect-direct method described in the writings of E. R. Hart, using a good stone instead of amalgam for the die. Dr. Hart contends this can be kept at the desired temperature while manipulating the wax and allows for more artistic carving. Under the head of investing materials, we find that climatic conditions and even transportation very often affects the material to such an extent that it is safer to test each can of investment before using rather than relying on the curve of expansion as printed on the package. I would go farther than Dr. Coy in summarizing the requirements for making a better cast inlay. He stresses three variables: wax, investment and gold; whereas, cavity preparation of utmost nicety is the first prerequisite and, last but not least, reducing flame and separate crucibles for treating residue buttons of each gold alloy should be used, as otherwise almost anything can happen to those alloys with platinum content.

COMPENSATION CASTING TECHNICS, MATERIALS, APPLIANCES AND DATA, 1910-1932*

By C. S. VAN HORN, D.D.S., Bloomsburg, Pa.

SINCE 1910, when I introduced a compensation casting technic based upon intelligently utilizing the physical properties and the behavior of pattern wax and investing material to compensate for the shrinkage in gold when passing from a liquid to the solid state in an investment mold, it has been interesting to observe the trend of thought and opinion as expressed by the various writers on the subject of dental inlay casting.

In the article, "Casting: A Review and Commentary, Including a Technique Which Makes Possible a Casting of the Same Size as the Wax Pattern at Body Temperature,"[1] it was clearly set forth, and illustrated, that to make a gold casting to the marginal dimensions of a wax pattern in a tooth cavity *in situ*, with the materials then available, it was necessary to utilize intelligently both wax and investment expansion to compensate for the shrinkage in the gold.

It was tacitly set forth that when a wax pattern is finally fitted to the margins of a tooth cavity *in situ*, the temperature of the wax is relatively body temperature; hence, the only available or effective wax movement is that expansion which occurs above 98 F., approximately.

It was further strongly indicated that efficient execution of a compensation technic requires at least a working knowledge of the materials employed and necessitates appliances which will induce and control, within reasonable limits, the thermal expansion of both the pattern wax and the investment.

In a paper, "Standardizing the Investing Process and Simplifying the Casting Process,"[2] there was introduced an investing standardizer and also a casting machine, which will be mentioned later. In that paper, after calling attention to the physical behavior of pattern wax, I had this to say (page 1111): "To standardize the investing process the appliance must be capable of not only imparting through the plastic investment a given temperature to the wax pattern, but it must maintain this definite temperature until the investment has thoroughly hardened." And after describing the appliance, which consisted of a water bath in which the flask was placed, I said: "The flask with its invested pattern is to remain in the water-bath—no water coming in contact with the investment—without any change in temperature, until the investment has thoroughly hardened, which takes about one-half hour."

It is to be noted that, in this construction, but one end of the flask was

*Read before Pennsylvania State Dental Society, Harrisburg, May 3, 1932.

1. Van Horn, C. S.: D. Cosmos, 52:873 (Aug.) 1910.

2. Van Horn, C. S.: D. Cosmos, 53:1109 (Oct.) 1911.

sealed, there being a specific reason for this, which will be emphasized herein.

In May, 1912, under "The Wax Pattern: A Technique, Together with Appliances, Etc., for Its Execution,"[3] the wax-tray-liquid-wax process, for direct pattern inlay technic, was introduced. The object of this method of manipulating nonplastic pattern wax is: (1) to neutralize any elasticity induced in the wax by stretching or bending when placing it in the tooth cavity, and (2) to effect more exact contact and continuity between the prepared cavity margins and the corresponding wax pattern.

In a paper, "The Importance of Recognizing Temperature Changes and the Sequelae When Executing Cast Gold Inlay Technique,"[4] it was set forth that open mouth temperature was not average room temperature, that to reduce the casting of gold inlays to a mathematical problem, the critical figures used in computing the success or failure of the fit of the finished product (the casting) must be: (*a*) the temperature at which the wax pattern is made; (*b*) the dimension change for temperature change in the wax pattern; (*c*) the shrinkage in gold when passing from the fluid state to the finished inlay; (*d*) the dimension change in mold at the time the cast is made; (*e*) the temperature at which the wax pattern is invested, and that zero dimension of the wax pattern must be placed at tooth cavity temperature, 95 F., or slightly higher.

Also, in 1920, there was presented a paper under the title, "An Electro-Pneumatic Casting Machine. Reducing Dental Inlay Casting To a Scientific Process."[5] To quote from that paper, under the caption "A Bit of Casting History":

> My first casting machine consisted of a tin ointment-box cover nailed to the end of a stick, a No. 13 S.S.W. Bunsen burner upon which was fixed a brass flask seat and a gas blow-pipe. This machine was used prior to 1908, its principal function being to establish two principles: (1) That dental casting, by a technique which I had *theoretically* perfected, was possible, and (2) that maintaining a hot mold up to the moment the gold is cast into it is not only desirable, but a scientific proposition.
>
> The second machine was a slight improvement. The third was more elaborate and more reliable owing to its *mechanical* construction, though the same Bunsen and flask seat were used. This machine was publicly demonstrated before the Lycoming Dental Society in 1908.
>
> The fourth machine consisted of a No. 13 S.S.W. Bunsen burner and a special flask seat and tube attached to the Elgin vacuum machine. This machine was used regularly in my practice up to the time of perfecting the Electro-Pneumatic which was conceived over ten years ago and born November 22, 1919.

Under "Foundation Principles," I wrote:

> The Electro-Pneumatic is founded upon the same principles as was my first casting machine, but by virtue of its mechanical construction, positive temperature records, automatic action, and fool-proof operation reduces dental casting to a positive proposition—relatively an exact science when used in conjunction with the wax-tray method, the expanded pattern technique, and materials of *known physical properties.*

That casting machine was, and still is, a rather wide departure from conventional practice in that means are provided for maintaining definite temperatures of the investment throughout the casting process.

Since most of the departures from conventional practice in inlay casting by the direct pattern technic which had

3. Van Horn, C. S.: D. Cosmos, 54:973 (May) 1912.

4. Van Horn, C. S.: D. Items Int., 42:344 (May) 1920.

5. Van Horn, C. S.: D. Cosmos, 62:1306 (Nov.) 1920.

been advocated were, to judge by the literature, received by the profession with the proverbial "grain of salt," I endeavored to emphasize the vital importance of taking full cognizance and advantage of the physical behavior of the materials used, gold, wax and investment, by a series of experiments in which I had the hearty cooperation of a few unselfish practitioners who were deeply interested in dental development. The report of the results obtained by that cooperative group was published under the title, "Eliminating Variables in the Making of Cast Gold Inlays."[6] That report illustrates rather conclusively the folly of ignoring the physical behavior of the materials used. It is to be observed that, in this series, castings were made from measured wax patterns; that measurements were taken at room temperature, approximately 70 F., and that essentially all of the various technics then. and now, in vogue were embodied. Especially is it to be noted that had the measurements of the patterns been taken at tooth cavity temperature (95-98 F.), the discrepancies would have been proportionately greater.

In 1922, there was inaugurated in our National Bureau of Standards a cooperative dental research program which was continued with the Weinstein Research Laboratory until 1928, when the American Dental Association became interested in this valuable cooperative work at the Bureau, which it continues to support.

This research, as far as dental inlay casting is concerned, has been confined rather largely to the behavior of the materials, gold, pattern wax and investment, under laboratory observation and conditions, i.e., until very recently, judging by the progress reports, there had been little effort made in calling to the attention of the profession the established and important fact that mouth conditions are vastly different from laboratory conditions; hence, the futility of adhering to a technic which has been established by adapting a wax pattern to a steel die, at average room temperature, in the hope that this technic will result in a casting which will fit a tooth cavity *in situ* as it does the steel die in the laboratory.

The importance of having accurate data on and of fully recognizing specific conditions in the immediate field of operation, of taking full cognizance of the exact behavior of all materials when passing through the necessary manipulative procedure and temperature changes incident to any direct pattern technic, is quite fully realized and amplified by endeavoring to make castings to the dimensions of a wax pattern at 95-98 F., by adhering strictly to some of the compensation technics advocated during the last three or four years and using the materials specified in accordance with instructions and without modification.

June 9, 1931, I read a paper, "Concerning Data, Materials, Conditions, Devices and Methods of Procedure Relative to Establishing Standardization in Dental Casting,"[7] before the Alumni Association School of Dentistry, University of Pittsburgh, the main object of which was expressed in the concluding paragraph:

> This paper endeavors to convey to the profession in general and to the research workers and the technicians in particular who are interested in dental development, what standardization in dental inlay casting really involves, to emphasize the folly of experiments which ignore established facts

6. Van Horn, C. S.: D. Cosmos, 67:159 (Feb.) 1925.

7. Van Horn, C. S.: D. Cosmos, 74:474 (May) 1932.

pertinent to the immediate field of operation, to suggest a logical means by which wax patterns, for test purposes, may readily be made under mouth conditions, and finally, that the knowledge gained through the proposed series of experiments be utilized in establishing a logical cast gold inlay technic, the selection of suitable materials and the adoption of appliances which make possible definite execution throughout.

A secondary object of that paper was to sound a note of warning against overenthusiasm relative to the recently developed high expansion investments and adopting, without question, the specific technics advocated for their use. The main reason for that warning was this: The fundamental principles upon which the compensation technic of 1910 was established are, seemingly, but little known, and, in consequence, some of the recent alterations of that technic are a bit too diverse for practical application to work in the mouth by any direct pattern technic with present (or past) pattern waxes, and any present investment.

I am inclined to believe that, owing to recent rather wide publicity in both the text and advertising pages of our journals, compensation casting technics are looked on by perhaps a rather large portion of the profession as something "new and revolutionary," and, like most new hobbyhorses, are being ridden, perhaps, rather inconsiderately.

To quote from an article by Drs. Volland and Paffenbarger, "Cast Gold Inlay Technic as Worked Out in the Cooperative Research at the National Bureau of Standards and Applied by a Group of Practicing Dentists"[8]:

> The wax expansion technics proposed around 1910 were practically discarded by the profession for a period of years, but were resuscitated and have been rather extensively used in various forms during the last three or four years. This renaissance was largely due to the publishing of definite values for wax and investment expansions. At the present time, the trend seems to be away from it, owing largely to the development of high expansion investments, some of which are able to compensate for all of the gold contraction. Certainly attempts to compensate for more than half of the gold shrinkage by wax expansion are unnecessary and complicated.

I am not taking issue with Drs. Volland and Paffenbarger, but should like to point out that, to the best of my knowledge and belief, the wax expansion technic which I proposed in 1910 was, if we are to judge by the literature from then to now, not discarded, but was and still is being distorted by the profession; and, secondly, to correct any assumption that this 1910 technic was confined to wax expansion alone. It was not, as was specifically stated in 1910 and in subsequent papers which I presented on the subject. That technic was then and is now, when intelligently applied, purely and simply a compensation technic based upon logically utilizing the thermal expansion of the pattern wax and the thermal expansion of the investment to compensate for the shrinkage in the gold when passing from a molten to the solid state in an investment mold.

That technic did not include as a critical computation figure the setting expansion in investment, but it did then and does now consider profoundly the setting time of the investment as a vital factor in results obtained. Furthermore, it never has and never will consider confining (plastic) investment, against free movement (displacement), by closing the two ends of the flask with a rigid metal disk or seal. Nor does that technic approve the practice of lining

8. Volland, R. H., and Paffenbarger, G. C.: J. A. D. A., 19:185 (Feb.), 1932.

the conventional inlay flask with sheet asbestos as a means to the end that an investment will displace the asbestos and expand uniformly under thermal influence.

From 1910, I have frequently and persistently endeavored to emphasize the fundamental principles upon which a compensation casting technic must be established. I have pointed out repeatedly and emphatically the importance of having materials the behavior and correct manipulation of which must be known and which must be in accord with the fundamental principles involved, and have called particular attention to the necessity of having suitable appliances logically utilized. Again, by way of continued emphasis, the following is appended as being particularly pertinent to any compensation casting method, ancient or modern, by the direct pattern technic, if the desideratum be casting to the dimensions of the prepared margins of a cavity in a tooth in the mouth.

1. Elasticity in stretched nonplastic wax must be neutralized prior to removing the finished pattern from the tooth cavity. It is believed that this can best be accomplished by utilizing the nonplastic wax-tray method and plastic liquid-wax process for making all patterns where stretching or bending of the nonplastic wax is liable to occur when placing it in the tooth cavity.

2. The mixed investment which surrounds the pattern and that which is poured, not vibrated, into the flask must be and must remain sufficiently soft not to inhibit wax movement until the invested pattern fully assumes, through the soft investment, the temperature required to effect the necessary voluminal adjustment of the mold. This applies to all investments irrespective of their expansion ability, and is the foundation upon which "standardizing the investing process" was founded in 1911. It clearly differentiates between an investing standardization technic, and a mere wax expansion technic and a technic which depends wholly on investment expansion.

3. The wax pattern must in no way be hindered from moving uniformly in all directions in the soft investment; hence, a given quantity of plastic investment dare not be confined in an equal chamber surrounded completely by rigid metal or other nonyielding walls, as when both ends of the conventional cylindrical inlay flask are sealed rigidly, or when the wax pattern is encapsulated, wholly or partially, in a nonyielding mass of investment, as in the so-called hard core technics.

4. In testing the setting time of investment material to ascertain whether or not it remains in a sufficiently plastic state after the pattern is invested and the flask is placed in the water-bath, the following procedure is suggested:

> Mix the investment with the stated quantity of water and in the manner prescribed. Manipulate the material to meet the stipulated requirements of the technic advocated, coating any suitable piece of wax in accordance with the technic under test. Place that *coated* wax pattern, not in the flask, but in the same temperature as the technic which is being followed calls for, and note the time.

If that investment mass, in that specified temperature, becomes sufficiently rigid to inhibit the free movement of the encapsulated wax, before the wax can possibly assume the desired temperature to effect the required voluminal adjustment of the mold, that investing technic or that investment, or both, are not suited to the purpose for which they were designed when manipulated in the manner advocated.

5. When an investment which has

an expansion greater than the expansion in the flask is used, the flask in which that investment is contained should have either a coefficient of thermal expansion equal to the expansion of the investment, or should have a flexible construction which will not unduly resist a uniform movement of the investment.. Otherwise, distortion of the mold may obtain.

6. Investments showing an expansion curve which remains relatively constant (flat) between, say, 1200 and 1400 F. are much to be preferred to an expansion of, say, 0.1 per cent between those two temperatures. Shrinkage between those two temperatures eliminates the investment.

7. Present, and past, inlay investments of good quality when heated in an oven to a predetermined degree, say from 1200 to 1400 F., in the average inlay flask, and the flask transferred to a casting machine with no means provided to maintain the required mold temperature, lose heat and contract rather rapidly. This drop in mold temperature is around 50 degrees F. or more a minute for the first few minutes, and if but two minutes elapse from high temperature to mold temperature at the moment of casting, there may be a drop of 100 degrees F., and a mold shrinkage of 0.1 per cent. It is obvious, therefore, that mold temperature should, within reasonable limits, be maintained if "precision" casting is the desideratum.

8. "Neutralize" and "compensate" do not necessarily imply specifically the same thing. To say that an investment is "able to compensate for all of the gold contraction" implies, specifically that, under given conditions, it has an expansion equal to the contraction in gold (1.25 per cent); hence, investment expansion will neutralize gold contraction if the casting is made at the temperature at which the investment has the neutralizing expansion (1.25 per cent), but as to whether full compensation obtains in the inlay technic depends, specifically on whether or not the technic in its entirety is conducive to the full realization of the neutralizing property in the investment.

IMPROVEMENT IN MATERIAL

As far as I know, there has been no improvement made in pattern waxes since Taggart's original. They have the same general characteristics, the same artistic temperament, if you please, which requires coaxing and petting, and when "crossed" exhibit several kinds of perversity. It is my belief that the "elastic property in stretched wax" can best be neutralized by the wax-tray method, and that inlay patterns so made in tooth cavities properly formed will be relatively free from distortion during the investment standardizing process, provided the pattern is not held or restrained by the investment from freely moving. To release the "elasticity in stretched wax," the wax (tray) must be heated throughout, preferably in a water-bath, not in an open flame, to a mushy state in which the wax is *without firmness* but retains its form; and in cooling (shrinking) it must in no way be held or restrained, else it will be restretched, elasticity again resulting.

WRITING SPECIFICATIONS

Except for a persistent tendency on the part of most manufacturers to make investing material that sets much too quickly for practical application in compensation casting technics, there has been a marked improvement in investments in recent years. This improvement is largely a direct result, I believe, of the important data compiled and published through the cooperative research at the

Bureau of Standards. If this research should see fit to modify A.D.A. Specification No. 2: "Tentative Specification for Dental Inlay Casting Investment (Approved July 24, 1930)," along the lines indicated in paragraph "4," above, beneficial results in present inlay casting technic would, I believe, accrue.

The cooperative research at the Bureau is, I believe, narrowing down to the point of supplying accurate data on the actual behavior of the materials when manipulated under mouth conditions and passing through the necessary manipulative procedure in the dental office and laboratory. This seems quite evident when consideration is given to the fact that the report previously referred to[8] emphasizes, in fact insists, that, in considering the application of any compensation casting technic involving a wax pattern fitted to a tooth cavity *in situ,* zero dimension of the wax pattern must be placed at tooth cavity temperature. That is a very broad step directly on the path of standardization.

I look on that article as being of more direct value to the research worker, to the technician, to the average dentist and to the dental manufacturer as a guide to evaluating the efficiency of technics, materials and appliances; in determining the cause of and avoiding failures, and in establishing sanity than any progress report which the Bureau has published. In my judgment, it will have a profoundly beneficial influence on subsequent dental casting activities and the results obtained.

WHAT DOES THE FUTURE HOLD?

Personally, I am not deeply interested in those compensation casting technics which "during the last three or four years . . . have been widely advertised and heralded as new and profound discoveries," for they either consist of mere modifications of no apparent value or, more often, are pure distortions of the fundamental principles of the compensation technic which I have been using for twenty years without any deviation at all from the foundation principles. This technic has from time to time been simplified, as has been set forth in previous articles, and the appliances necessary to its efficient execution have also been refined and their efficiency enhanced. The only improvements of importance which have not been publicly announced and described consist of a rather important modification in standardizing the investing process, and a marked departure from conventional centrifugal casting machines and the accessories. The electrocentrifugal casting machine is still under test.

MODIFICATION IN INVESTING STANDARDIZATION

It may be of interest to note that while all of the compensation casting technics published or advertised to date deviate more or less from a logical application of the 1910 technic, either by improperly using or manipulating the materials or through inefficiency in appliances, each and every one has followed implicitly a false concept which I established by a statement published in October, 1911 (page 1114)[2]: "The flask with its invested wax pattern is to remain in the water-bath—no water coming in contact with the investment — without any change in temperature, until the investment has thoroughly hardened, which takes about one-half hour." All of which implies that the working of the human mind is incomprehensible, as the following clearly indicates:

Several years ago, I discovered that mixed investment sets better and that its desirable qualities were seemingly en-

hanced when in contact with the water in the bath.

After rather exhaustive experiments with a variety of investing materials mixed with varying quantities of water and in various ways, it was observed that this submersion technic was sound, and that an investment which has hardened under and in contact with water may remain submerged for an indefinite period of time—days or weeks—without any apparent deleterious effect. This having been established, a series of test castings were made, and since that time this submersion technic has been used exclusively in my practical and experimental casting. Also, several others have been using this technic for two or three years, and since all reports are favorable, I feel that it may now be safely adopted by the profession with the assurance that the results will at least equal, and may possibly surpass, those previously obtained.

Four outstanding advantages accrue: 1. Temperature conduction, to the pattern, is reduced to the minimum interval of time. 2. Investment setting, temperatures being equal, is inclined to be retarded. 3. The plastic investment is neither confined nor compressed in the flask; hence, wax movement is unrestrained and a consequent uniform (unwarped) voluminal adjustment of the mold is assured, provided, the investment which encapsulates the pattern is and remains plastic, as previously specified. 4. Patterns may be invested at any convenient time, or a specified time, if you prefer, and, if they are left submerged, the casting operation may be carried through at any other convenient time with the assurance that results will be equal to those carried through in a specified time.

CASTING TO WHAT DIMENSIONS?

The purpose of this paper is to suggest to the profession, to the research worker, to the technician and to the manufacturer that this question be confronted: Is the technic, the materials and the appliances which I am using or testing or advocating capable of producing dental inlay castings the marginal dimensions of which register with the corresponding prepared marginal dimensions of a cavity in a tooth in the mouth; or is that technic or that material or that appliance, through some inherent or manipulative "flaw," limited to casting to the dimensions of a pattern of a mesioclusodistal steel die at average room temperature?

On the logic—the saneness, if you please—embodied in the answer depends the success of the margins of an inlay thus cast to register with the prepared margins of the cavity in a tooth in the mouth.

I am optimistic.

424 Iron Street.

THE MICROHARDNESS OF TEETH*

By HAROLD C. HODGE, B.S., M.S., Ph.D., Rochester, N. Y.,
and HAROLD McKAY, Buffalo, N. Y.

HARDNESS,[1] a word used in everyday life, in a technical sense is employed to express five ideas: the resistance a material offers (1) to scratching, (2) to indentation, (3) to elastic impact, (4) to cutting and (5) to permanent deformation. The various types of hardness-testing instruments employ some one quality or combination of these qualities as a basic principle; hence, the large number and variety.

Recently,[2] there has been reported a comparison of various commercial hardness testers as applied to tooth tissues. These instruments, although embodying different principles and of varying degrees of delicacy, showed a qualitative agreement as to the relative hardness of enamel and dentin. Many of the instruments destructively distorted tooth tissue, and it was concluded that owing to, first, smallness of teeth and, secondly, sharp gradients in hardness, a more delicate instrument is required for hardness studies of these tissues.

What questions might be answered by a delicate instrument capable of detecting the minute changes in hardness of the varying parts of the teeth and similar teeth under different conditions? Karlström was able to say definitely that the first permanent molar belongs to the second rather than to the deciduous dentition on the basis of hardness measurements. Clinically, it has often been noticed that certain teeth are easy to drill, others difficult. Does this depend on a difference in hardness of the tissue, and, if so, is there correlation between this hardness and caries incidence? Do metabolic diseases cause changes in hardness? Are there changes in the hardness of teeth of woman patients during pregnancy? If there are, physical measurements should show some basis for conclusive argument on the validity of the proverb "For every child, a tooth." Are there changes in teeth after their eruption, rendering them resistant to caries? Does pyorrhea cause a change in hardness of the teeth? Are teeth worn by attrition more subject to decay by virtue of changes in their hardness? Are teeth taken from the mouths of aged persons harder than those from youths? In these questions, where chemical research so far has not been enlightening, it is necessary to study the physical characteristics of the hard tissues in a rigorous fashion with the hope that new lines of evidence may be obtained.

Pickerill,[3] using a scratch method,

*Read before the Section on Histology, Physiology, Pathology, Bacteriology and Chemistry (Research) at the Seventy-Fourth Annual Session of the American Dental Association, Buffalo, N. Y., Sept. 14, 1932.

1. Hofman, H. O.: General Metallurgy, New York: McGraw-Hill, 1913, p. 9.

2. Hodge, H. C.: J. D. Res., to be published.

3. Pickerill, H. P.: Prevention of Dental Caries and Oral Sepsis, New York: Paul Hoeber, 1924, p. 112.

showed a 25 per cent difference in the hardness of native Maori, sclerotic and malacotic teeth. Burg,[4] using a scratch method, observed that, in the dentin, the direction of scratch was unimportant, but, in enamel, a scratch parallel to the enamel rods gave lower, and across the enamel rods higher, hardness values. He noted further that the outside of unworn teeth gave the highest hardness. Proell and Schubert,[5] using a scratch method, confirmed Burg's observation on the hardness of the outer surface of unworn teeth. They found no difference in hardness in different directions in the enamel. They noted that structure seemed to play no part in the degree of

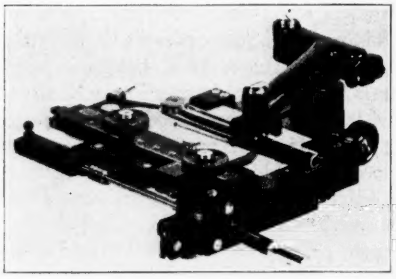

Fig. 1.—Microcharacter.

hardness except in the dentin, where they found transparent dentin harder than normal. Richter,[6] following Proell and Schubert, noted that deciduous enamel was softer than permanent and that pyorrheic teeth are harder than normal teeth. He also reports that there is no difference in the hardness of dentin in carious and in sound teeth, in teeth from pregnant and nonpregnant women.

The scratch methods employed may be criticized principally on the basis of their grossness, that is, they are qualitative and permit only a few determinations on one sample.

The microcharacter,[7] shown in Figure 1, is an instrument designed primarily for testing the hardness of crystals in bearing metals. As these crystals are microscopic, the microcharacter is well

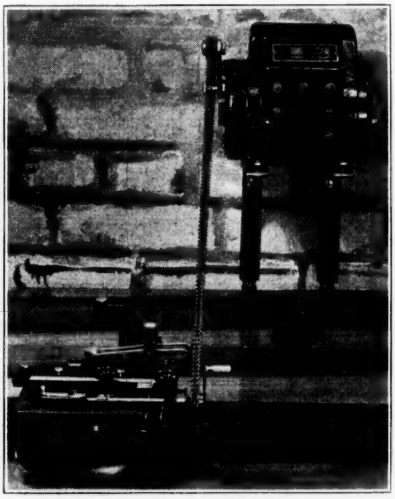

Fig. 2.—Microcharacter with motor mounting and drive.

adapted to the study of small specimens and sensitive to sharp changes in hardness. Therefore, its use in testing the hardness of tooth tissues was essayed. The microcharacter consists essentially of a tiny diamond ground to the corner of a cube. The precision of this grinding is attested by its perfect sharpness

4. Burg: Neue spezielle Härtebestimmungen der Hartsubstanzen des Zahnes. Dissertation, Jena, 1921. (Quoted from Proell, Schubert and Richter.)

5. Proell and Schubert: Die Ritzhärte des Zahnschmelzes, Ztschr. Stomatol., 26: 1047-1063, 1928.

6. Richter: Härteprufung an Schmelz und Dentine II, Ztschr. Stomatol., 29: 591-606, 1931.

7. Bierbaum, C. H.: Study of Bearing Metals, A.I.M.E., February, 1923; Michrocharacter, A.S.S.T., September, 1930.

at a magnification of 2,000 diameters. This diamond is mounted in such a way as to operate with the diagonal of the cube at 90 degrees to the test surface and with the edge of the cube entering the test material as the latter is moved under the cutting point. A constant load is maintained by means of a small weight mounted on a lever-spring system regulated by a screw and indicated by a spirit level. This instrument gives a highly reproducible cut in contradistinction to the scratch produced by the instruments previously used.

In order to remove the personal element in making the microcut, an electric motor (Fig. 2) was mounted with a chain and sprocket drive. The motor contains a set of reducing gears which rotate the drive shaft of the microcharacter at a rate of about 2 r.p.m. Through a micrometer screw, the shaft of the michrocharacter moves the test tooth mounted on a slide underneath the diamond point at the rate of 0.1 mm. a minute.

(In private communication from Mr. C. H. Bierbaum, the patentee of the microcharacter, we received this comment concerning the speed of cutting: "When you come to the question of the rate of feed, very evidently we have given you a wrong impression, in that the feed you speak of may be multiplied by 10. We do not move any slower than 5 mm. per min. on our hardest and most heterogeneous steels. On the tooth sections you do not approach anywhere near these extremes, and you can well multiply this speed by 10, so that a cut 2 cm. long can be made with perfect accuracy upon any tooth section in two to three minutes.")

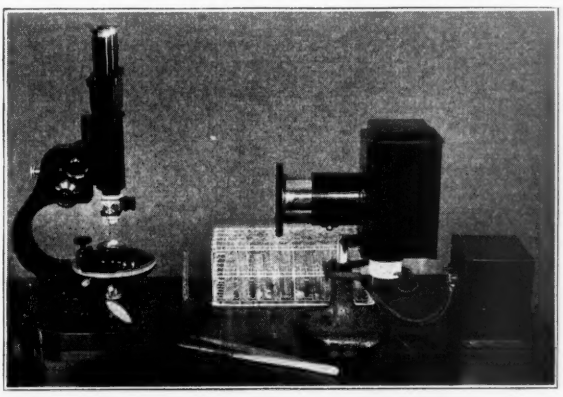

Fig. 3.—Microscope and illuminator.

The surface bearing the cut is then examined through a microscope (Fig. 3) with vertical illumination. A ribbon filament lamp was found best suited to be a light source and a silvered half-mirror was used in the vertical illuminator. Measurements were made at a magnification of about 900 diameters. It must be emphasized that the work is very painstaking.

Since the degree and accuracy herein attained is equal to the limit of the modern microscope, the cut obtained is called

"microcut" and the hardness termed "microhardness." The "microhardness" or "Bierbaum hardness number" is the ratio of the area of impression by the force producing the impression.

The measurements recorded below were made on dry tooth surfaces. The cuts were made with a 3 gm. weight and were measured with a 4 mm. dry objective and 15 x filar micrometer ocular by which 1 division equals 5.5 microns. The microhardness is obtained by multiplying the square root of the width in microns by 10,000. The cuts are affected by the anisotropicity of the tooth hard substance. It is evident, therefore, that these data are of comparative, not absolute value.

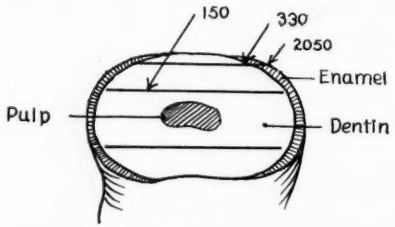

Fig. 4.—Hardness of dentin and enamel of cuspid.

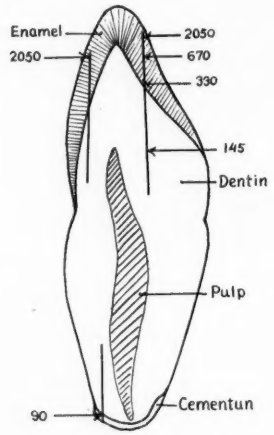

Fig. 5.—Hardness of cementum, dentin and enamel of cuspid.

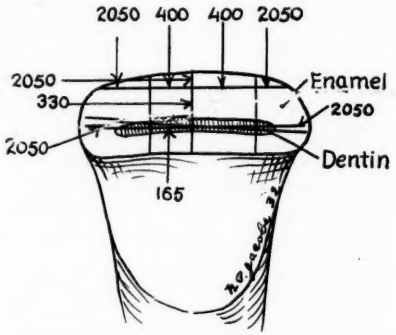

Fig. 6.—Incisor worn by attrition; showing hardness of dentin and enamel.

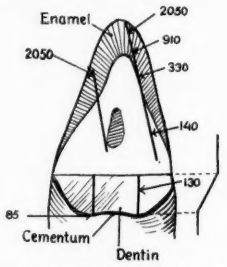

Fig. 7.—Hardness of two faces of dentin, cementum and enamel of cuspid.

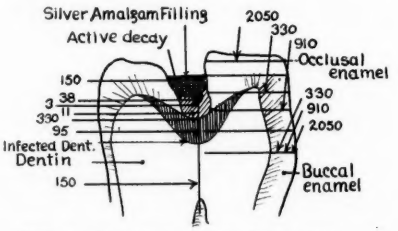

Fig. 8.—Hardness of amalgam filling, decay, infected dentin and buccal and occlusal enamel of molar.

In the tooth diagrammed in Figure 4, a section cut at right angles to the long axis of the tooth shows enamel, dentin

and pulp cavity. There have been made three microcuts parallel across this plane surface. It is observed (Table I) that the hardness of the dentin as represented by 150 shows a relative softness when compared to the inner portion of the enamel whose hardness may be represented by the figure 330.

It is interesting and even amazing to note that the extreme outer shell of enamel has a maximum hardness on the same scale represented by 2,050.

Figure 5 shows a sagittal section of a cuspid in which enamel, dentin, pulp and cementum are outlined. The dentin of this tooth has an average hardness (Table 2) of 145, the cementum of 90.

In the relatively thick layer of enamel, three zones of hardness were easily observable: the innermost, next to the dentin, whose hardness was about 330; midway through the enamel, a zone having a hardness value of 670; and, in the outer shell of enamel, a maximum hardness value of 2,050, whether measured

TABLE I.—COMPARATIVE HARDNESS OF DENTIN AND ENAMEL

	Dentin	Outside Enamel	Inside Enamel
Readings in Divisions	1.5	0.4	0.7
	1.3	0.4	0.8
	1.4	0.5	0.6
	1.7	0.5	0.9
	1.6	0.4	1.0
	1.5	0.4	0.8
	1.7	0.5	0.9
	1.3	0.4	1.0
	1.6	0.5	0.8
	1.4	0.4	0.6
Average	1.50	0.44	0.81
Width in Microns	8.25	2.40	4.45
Microhardness	150	1,750	500

TABLE 3.—COMPARATIVE HARDNESS OF ENAMEL AND DENTIN

	Outside Enamel	Inside Enamel	Dentin
Readings in Divisions	0.4	1.0	1.3
	0.5	0.9	1.4
	0.4	1.0	1.5
	0.5	0.9	1.3
	0.6	0.8	1.4
	0.4	0.8	1.5
	0.5	0.7	1.3
	0.4	0.6	1.5
			1.5
			1.5
Average	0.46	0.84	1.42
Width in Microns	2.50	4.60	7.80
Microhardness	1,600	473	165

TABLE 2.—COMPARATIVE HARDNESS OF DENTIN, CEMENTUM AND ENAMEL

	Dentin	Cementum	Outside Enamel	Inside Enamel
Readings in Divisions	1.7	2.0	0.4	0.6
	1.3	1.9	0.5	0.7
	1.5	1.7	0.3	0.8
	1.7	1.9	0.5	0.9
	1.6	1.9	0.4	1.0
	1.4	2.0	0.5	0.9
	1.6	1.9	0.4	0.8
	1.5	2.0	0.5	0.7
	1.4	2.1	0.4	0.6
	1.4	2.0	0.4	0.8
Average.....	1.50	1.94	0.44	0.78
Width in Microns...	8.25	10.67	2.40	4.30
Microhardness.....	145	90	1,750	560

on the lingual or on the labial side of the tooth.

In Figure 6, an incisor worn by attrition, cut near the incisal edge by a plane at right angles to the long axis of the outer shell, whether measured on the mesial, distal, labial or lingual sides, an average hardness of 1,600 and a maximum of 2,050.

In a cuspid cut sagitally (Fig. 7),

TABLE 4.—COMPARATIVE HARDNESS OF DENTIN, CEMENTUM AND ENAMEL

	Dentin in Crown	Dentin in Root	Cementum	Outside Enamel	Inside Enamel
Readings in Divisions	1.5	1.5	2.0	0.4	0.6
	1.4	1.6	2.1	0.4	0.7
	1.5	1.7	2.0	0.5	0.8
	1.6	1.7	2.1	0.6	1.0
	1.5	1.6	1.9	0.4	0.9
	1.3	1.5	1.8	0.5	0.8
	1.5	1.6	2.1	0.5	0.7
	1.7	1.7	2.0	0.6	0.9
	1.5	1.5		0.5	1.0
	1.7	1.6		0.5	0.9
Average	1.52	1.6	2.0	0.49	0.83
Width in Microns	8.36	8.8	11.0	2.70	4.57
Microhardness	140	130	85	1,372	475

TABLE 5.—COMPARATIVE HARDNESS OF VARIOUS AREAS

	Dentin	Incipient Decay	Infected Dentin	Active Decay	Silver Amalgam	Outside Enamel	Inside Enamel	Red Area at Base of Amalgam
Readings in Divisions	1.3	1.0	1.9	10.0	1.7	0.3	0.5	2.8
	1.4	1.0	2.0	13.0	1.3	0.4	0.5	3.0
	1.5		2.0	12.0	1.7	0.4	0.6	3.0
	1.4		1.5	11.0	1.1	0.5	0.6	
	1.5		2.0	6.0	1.5	0.5	0.7	
	1.6			15.0	1.5	0.4	0.8	
	1.5			3.5	1.3	0.5	0.9	
	1.6			4.5	1.2	0.4	1.0	
	1.6			14.0	1.7	0.5	0.8	
	1.5			8.0	1.8	0.4	0.9	
Average	1.49	1.0	1.88	9.7	1.48	0.43	0.73	2.93
Width in Microns	8.20	5.5	10.30	53.0	8.10	2.37	4.00	16.12
Microhardness	150	330	95	3.50	150	1,800	625	38

tooth, shows dentin of a hardness of 165. (Table 3.)

Near the dentin, the average hardness of the enamel is 330. Between this enamel and the outer shell is found a hardness of 400, and, in the extreme dentin near the root portion of the tooth shows a hardness of 130; cementum in the same portion giving a hardness of 85. (Table 4.) Higher in the crown of the tooth, the average value for the hardness of the dentin is 140.

In the enamel near the dentin is observed a hardness of 330; in the middle enamel, the hardness is 910, and, in the outer shell, the enamel gives a maximum hardness of 2,050.

Figure 8 shows a molar in whose occlusal surface an amalgam filling has been placed. There is active decay evident beneath the filling, with infected dentin plainly shown in a wide cone stretched down toward the pulp from the dentino-enamel junction. The hardness (Table 5) of the dentin in the healthy portion of this tooth is 150 and, by coincidence, the hardness of the silver amalgam filling is 150 also. Immediately beneath the filling and surrounded by the putty-like mass of active decay was a red island whose hardness was 38. Immediately below this island, in the active decay, the hardness values are 3 and 11.

Passing from the zone of active caries into the infected dentin, we were surprised to note a thin wall in the dentin whose hardness was 330, or almost twice the hardness of normal, healthy dentin. In the zone of infected dentin, hardness values of 95 were observed. It is interesting in this tooth to compare the hardness of the occlusal and the buccal enamel. Here is found only verification of earlier observations; namely, that the hardness of the enamel varies from 330 to 910 as we go from the dentin through about nine-tenths of the thickness of enamel, while the extreme outer edge both of occlusal and buccal enamel maintains a maximum value of 2,050.

These data are to be accepted as a preliminary to further study. Suffice it to say that we have here an instrument by which we may satisfactorily measure one of the physical properties of the hard substance of the tooth with a sufficient degree of precision and minuteness to qualify it, in our opinion, for extended research into the quality of the hard substance of the tooth.

SOME NUTRITIONAL PHASES OF DENTAL CONDITIONS*

By PERCY R. HOWE, D.D.S., Boston, Mass.

THE entire dental profession has watched with interest the most unusual growth and expansion of dentistry which has taken place within the past few years. It has been a case of "needs must," with dental disturbances at their very peak in respect to numbers, and dentistry has risen to the occasion.

In no respect has this growth been more striking than in the adoption of physiologic principles which have been applied to every branch of our science. The construction of dentures, the practice of orthodontia, the arrest of caries now rest on an understanding of these principles. We have gone back to the time when the teeth and maxillae are in process of formation, seeking to build normal arches and rugged teeth.

At the very basis of physiology lies

*Read before the Section on Partial Denture Prosthesis at the Seventy-Fourth Annual Session of the American Dental Association, Buffalo, N. Y., Sept. 13, 1932.

nutrition, and at the basis of nutrition, the food which thrice daily is introduced into the alimentary tract. It is only recently that specific effects of food deficiencies and dietary excesses, which have a most marked effect on the teeth and on the bones which support them, have been demonstrated.

What takes place in the teeth takes place elsewhere in the organs and tissues of the body. Sometimes, the changes are insidious, requiring a considerable period of time to reach a crisis, and sometimes they occur with dramatic rapidity, this depending on the conditions of the experiment. It is recognized that experimental feeding does not represent precisely what occurs in every day life, for no diet is absolutely devoid of elements which, in experimental studies, are reduced to the lowest possible point. These studies do show that specific pathologic changes follow specific deficiencies, and since the first signs of some of these changes are found in the teeth, we have scientific grounds for holding that, in the condition of the teeth, we have a sure index of nutritional states which, if allowed to continue, ultimately result in serious complications.

One of the most astonishing and hopeful phenomena demonstrated in laboratories is the ability of tissue to recover. The "about face" of the cells—their resumption of normal function and the complete disappearance of pathologic signs when dietary correction is instituted and strictly adhered to for a sufficient length of time—is remarkable, to say the least.

Sometimes, I wonder if we do not allow ourselves to think too much about disease and not enough about health. There is the border line, the first creeping of water over the dam, and efforts at what we call prevention of disease all along the line are reaching farther back to this border line. Particularly is this so in dental matters. Certainly the axiom that "sound teeth are the natural corollary of a sound body" suggests as desirable a goal as the mythical slogan "a clean tooth never decays" and one much more possible of attainment.

With such an idea in mind, let us briefly review some of the dietary experimentation that has formed the basis on which attempts may be made to induce an improvement in the present state of the teeth.

The first attempts to study the effect of diet on the teeth in the laboratory were made by Mrs. Mellanby and by Zilva and Wells.

Mrs. Mellanby, in connection with her husband's well-known work on rickets, produced hypoplasia of the teeth in pups with the laying down of poorly formed dentin when what she then termed the fat-soluble (A) vitamin was absent from the diet. The enamel was but partially formed, while cessation of growth in the maxillary bones and mandible resulted in malposition of the teeth. Subsequent work on vitamins undertaken in many laboratories showed that vitamin A, as it was then designated, in reality consisted of two distinct vitamins, or, as they are now termed, A and D, and since Mrs. Mellanby's work was really on rickets, it was a vitamin D deficiency rather more than an A deficiency to which the effects she produced in pups should be ascribed.

At about the same time, Zilva and Wells were making a study of a deficiency of the antiscorbutic vitamin, or, as it is commonly called, the water-soluble (C) vitamin. They found that the teeth were the first part of the body in which this deficiency was to be detected, and, from their studies, they suggested that this vitamin deficiency might be a factor in caries.

On this side of the water, we had begun our studies on dietary effects on the teeth of laboratory animals, but had published no account of our work.

We began by studying the effect of vitamin C deficiency, using both guinea-pigs and monkeys. We then studied vitamin A deficiency, using purified diets with rats and subsequently with guinea-pigs. Miss Hatch, who has had wide experience in this work, was the first to rear guinea-pigs successfully on purified diets. We also fed diets deficient in or containing an excess of various food factors, some of which will be described. We had not been engaged in our studies for more than six or seven years when arrangements were made for us to carry on work in some of the laboratories in the Harvard Medical School as a part of our work at Forsyth Dental Infirmary. There, we have had the exceptional advantage of having Professor Wolbach interpret the effects of ingestion of the various vitamins on the tissues of the entire bodies of the experimental animals.

In general, the effect of a deficiency of vitamin A has been described as a widespread metaplasia of normal to squamous-cell keratinizing epithelium. In teeth, this deficiency results in atrophy of the ameloblasts to the point of cessation of the formation of enamel. Bone is frequently laid down in the enamel organ in irregular areas, especially in the vicinity of the blood vessels.

The odontoblasts also atrophy, but continue to lay down dentin in an imperfect fashion. They gradually shrink, and finally disappear. Preceding their disappearance, irregular down growth occurs. They mass at the sides of the pulp, and the tooth form becomes distorted. Denticles form along the sides of the pulp, and, within its body, islands of osteoid tissue form, incorporating and surrounded by osteoblasts.

A careful study of the early stages of this lesion has convinced us that the connective tissue cells take up the function and structure of the osteoblasts because the first step is the laying down of a hyaline, homogeneous matrix between normal-appearing connective-tissue cells.

There seems to be some relation between ameloblasts and odontoblasts since the most marked changes in the function of the odontoblasts occur in the region of the pulp remote from the enamel organ.

Changes also occur in the cementum with the formation of cementicles. When vitamin A is supplied, normal function begins gradually to be resumed. A deficiency of vitamin A thus results in arrest of enamel formation, development of imperfect dentin and pulp stones and distortion in tooth form, especially in the apical region.

Vitamin C deficiency, as found by a study of the teeth and the growth and repair of bones in respect to bone matrix, and also through a study of soft tissue in regard to collagen, is characterized by the inability of supporting tissues to produce and maintain intercellular substances. In the teeth, this is manifested by the withdrawal of the odontoblasts from the formed dentin, occurring in from five to seven days. Their orderly arrangement is disturbed. They take on deeper staining properties, become smaller, and cease to lay down dentin. The blood vessels in the pulp become distinct through engorgement. The formed dentin liquefies and the space between the odontoblasts and dentin is filled with a liquid. In ten days, the pulp in guinea-pigs' teeth appears shrunken, and the dentin is found to be undergoing destruction. When vitamin C is furnished, the odontoblasts are found to be beginning the laying down of intercellular substances in from twenty-four to forty-eight hours. In from

three to four days, new dentin forms.

Similar action is observed on the part of the osteoblasts. Lesions made in the femur of guinea-pigs in the scorbutic state show but little sign of repair as long as this condition is maintained, while in those that receive the antiscorbutic substance, the lesion heals in about ten days.

Probably more has been written about the D vitamin in connection with teeth than any of the other vitamins. It is on this vitamin that the work of Mrs. Mellanby is chiefly based.

Commonly called the antirachitic vitamin, it institutes a healing process in experimental animals within a few days of its administration. According to Mrs. Mellanby, the amount of calcium in the diet is relatively unimportant, provided an ample supply of this vitamin is afforded.

McCollum and Pipenheimer believe rickets to be due to a disproportion between the calcium and phosphorus content of the diet. Theoretically, if the proper balance was maintained, no D vitamin would be needed.

The outstanding initial morphologic feature in rickets is the disturbance of the sequence of ossification in epiphyseal cartilages. The earliest effect is the cessation of the degenerative changes in the cartilage, normally antecedent to its penetration by blood vessels from marrow and periosteum.

The cartilage cells continue to proliferate. They enlarge, remain viable and form a barrier beyond which blood vessels proliferate. Accompanying the vascular proliferation, an excess of bone matrix is formed. Concomitantly, the zone of provisional calcification is not maintained, and the bone matrix subsequently deposited does not calcify.

Conversely, the first morphologic evidence of repair is seen in the "degeneration" of the swollen cartilage cells and their penetration by blood vessels. In the teeth, hypoplastic enamel and imperfectly calcified dentin are found.

Do the same reactions occur in human beings as regards teeth? There has been considerable discussion as to this. At the Children's Hospital in Boston, some investigation of the matter has been made, and it has been found that the same changes have occurred. In one case of fat-soluble A deficiency, unrecognized clinically because no xerophthalmia had occurred, but determined by the examination of other tissues, the same dental picture was found as that described above as occurring in rats and guinea-pigs on vitamin-A deficiency. In scurvy and in rickets, the changes found in experimental animals were found by Wolbach and Boyle in infants during the formative period. It would, therefore, seem that there were reasonable grounds for believing that it is of importance, for the sake of sound teeth, to see that the diets of infants and young children are not deficient in these factors.

Such are the changes that take place as a result of vitamin deficiencies. The case does not rest here, but includes the whole field of mineral intake, retention and fixation.

Foods which yield an acid ash affect calcium utilization. The work which my colleague, Dr. Logan, carried out indicates that about 5 per cent of the absorbed calcium is used for neutralizing purposes. This might not be considered important except that, in the light of Sherman's often quoted conclusions that American diets are more deficient in calcium than in any other factor, it may be the straw which breaks the camel's back.

The state of the calcium in foods is still another consideration. Calcium from all foods is probably absorbed in the in-

organic form. It is rendered more readily available from some foods than others. For example, 81.82 per cent is absorbed from human milk; 60.70 per cent, from whole cow's milk; 53.72 per cent, from diluted cow's milk, and 32.55 per cent, from an artificial food. These are estimates given by Blandberg and quoted by Orr.

Recent studies on phosphorus are attracting considerable interest, especially those carried out on phosphatase in its relation to calcification. Appreciable amounts of this enzyme are present in the pulps of teeth, which, bringing about the hydrolysis of calcium containing esters of phosphoric acid, causes a deposition of calcium phosphate to occur.

Of still further interest is the demonstration of the permeability of enamel by organic phosphorus as shown by Jeffery. The permeability of the calcified parts of the teeth to various substances indicates that they may be susceptible to metabolic changes.

As far as our knowledge has developed, the more extensive use of milk, fruits and vegetables is to be recommended, for these foods contain the vitamins and mineral elements in an assimilable form.

Boyd and Drain have reported a remarkable arrest of caries through dietary control. Mrs. Mellanby, leaning strongly on the vitamin-D content of her diets, reports that the percentage of caries has been reduced in striking fashion.

At the Forsyth Dental Infirmary for Chillren, the nutrition department has records of about 500 cases in which the diet has been followed for from three and a half to one and a half years, with marked dental and general physical improvement. An account of this work is reserved for another paper, but suffice it to say that the observation of dietary effects on the teeth of children in clinics and in their homes leaves no dout as to the practicability of this means not only for the prevention of malformation of teeth and maxillary bones, but also for the arrest of existing caries.

DISCUSSION

George Wood Clapp, New York City: Dr. Howe probably knows more about the influence of nutrition on dental conditions than any other dentist of my acquaintance. There was a time when he made partial dentures in his practice and knew a great deal about them. That was years ago, when knowledge as to what partial dentures should be and might be and what effect they may have on oral structures was much less than it is now. In those days, we men who are now old in the profession had to make our own dentures and stand or fall in the community by their success or failure, and you may be sure that, poor as they were, they were the best that we knew how to make. For many years now, Dr. Howe has concentrated on studies far removed from partial denture construction and he is probably not informed about some extensive changes that have occurred in the way in which partial dentures in general are made. He may not know that because partial denture work is one of the most profitable forms of service open to the general practitioner, and because the immediate cash profit from it can be greatly increased by throwing away professional prerogatives, betraying public confidence and substituting ignorance and slipshod technic for professional knowledge and good technic, it is probable, on the average, as far as the part the dental profession is taking in it goes, about the most poorly rendered form of dental service today. He probably does not know that there is excellent reason to believe that two of every three partial dentures made in this country last year were designed not by dentists and on the basis of sound professional knowledge but by laboratory men, because the dentists of this country are steadily and determinedly rendering themselves less and less capable of designing partial dentures or any other prosthetic piece for that matter. He does not know that, in certain sections of this country, it is common practice for dentists to take snap impressions, send them to laboratories and ask for different designs of prosthetic pieces which can be put into that mouth with a price for each. This might not be so serious if there were

included in the impression or cast all that the designer needs to know, but that is rarely done or may be impossible. It might still not be too bad if all laboratory men were competent designers. A critic unusually well informed believes that not more than one laboratory man in a hundred is competent to make a good design, even inside the limits within which a laboratory technician should function. Proper design is rendered even more difficult now than usual, because most dentists are buying laboratory work on a price basis, and good design is often sacrificed to low price. Sometimes, the dentist asks the laboratory man what the fee to the patient should be. If you can think of any better way than this to help laboratory technicians justify their right to practice prosthetic dentistry, it might be worth while to publish it. If the laboratories get that right, several thousand dentists will promptly be starved out of practice. The dentist who gets a laboratory design and price usually begins his sales talk with the piece which will show him the greatest profit, without either knowledge or regard for the patient's requirements, and, failing to sell that, goes down the line of price until he succeeds in selling something. Dr. Howe probably does not know that two dentists in every three are apparently incapable of taking the very accurate impressions and bite which should be considered essentials for the construction of partial dentures, and refuse to master the technic for even that part of the work. He may not know that half of all dentists appear to be unable to make the adjustments of partial dentures in the mouth which are necessary to denture efficiency and, at the same time, the preservation of the abutment teeth. Not knowing these things, Dr. Howe did not adapt his message directly to the problem before us. But because he is my friend, and because there ought to be in this audience many who are interested in the construction of artificial dentures which will meet our professional obligations and keep faith with our patients, I am going to adapt some of the important information he has brought us today and other equally important things that he has taught me at other times to one or two of the simpler problems in partial denture construction, with the hope that he will further clarify the matter in closing the discussion. Let me summarize a few things from the paper: Dr. Howe has told us that nutrition lies at the basis of physiology, which is the science of healthy function. He might have added that malnutrition lies at the basis of pathology, which is the science of unhealthy function. He has shown that a deficiency in vitamins A, B, C, and D quickly causes injury to the mucous membrane of the intestinal tract, which includes the mouth, and to the circulatory system of the teeth. He has repeated one fact which ought never to be lost sight of by the dentist—that these changes are not limited to the tissues he mentions but are general in the tissues of the body. Partial dentures are sometimes tissue-borne, sometimes tooth-borne, sometimes borne by both teeth and tissues. They therefore depend for stability and efficiency on the adjoining teeth and the underlying tissues, and their presence has important effects on these teeth and tissues. Under such conditions, of what importance is nutrition to their success and durability? To get this information into practicable form, let us imagine two patients who require partial dentures involving the maxillary first and second molars on each side, so that we may have enough teeth on each side to permit good retention and balance. Let us agree that the cases are as nearly identical mechanically as possible. We shall omit all questions of materials and methods used in construction and shall consider that the problems of retention and of balance in function have been satisfactorily solved. We shall focus our attention on the two molars to be replaced on the right side because both of these patients masticate mostly on that side. All the teeth are present in front of the space where the denture molars are to go. The second bicuspid has a large disto-occlusal inlay, but is vital and apparently healthy. The third molar is in place and sound and vital. The molars on the mandible which will oppose the restoration are in position. They have been repaired, but are vital and capable of good function. We decide that, as far as we can bring it to pass, the denture shall be borne by the tissues when not engaged in mastication, but that the force which will come upon it in mastication shall be borne by the second bicuspid and third molar. Having obtained our mental pictures of the dentures as mechanically alike, let us look at the patients and find out what influence on design and construction and satisfaction their past and present habits of nutrition, exercise

and rest will have. We do this because, to paraphrase a clever saying by Weston A. Price, the kind of patient the denture has may sometimes be quite as important as the kind of denture the patient has. The first patient is Mr. Shultz, aged 50, weight 190 pounds, engaged in the wholesale fruit and produce business and accustomed to be much out of doors and to do some active physical work each day. The nutritional habits of his German ancestors and his own life show in his mouth. When he was a youth, he fell into the habits of some of his American boy friends and ate a great deal of candy, but a few severe toothaches and some painful extractions cured his liking for that, and the dental bill cured his father's liking for it, so he went back to the family diet and has stuck pretty closely to it—meat, fruit, vegetables, milk and very hard bread. He chews his food very thoroughly and likes to munch celery or raw carrots as he works. His arch is broad; the teeth, except for the four upper molars we are to replace, are present and vital; the soft tissues are in good condition, and there is little recession of the gums. Mr. Shultz masticates mostly on the right side, where we are to replace two molars. He will close the jaws at least 4,000 times daily in the mastication of his meals and, on some days, perhaps 3,000 times more in munching carrots or celery or some fruit. If these teeth were solid natural molars, he would close with a probable average pressure of at least 100 pounds. In studying the strain on the partial denture, let us give it more consideration than he will show it and estimate that he will close on these two teeth only 2,000 times in twenty-four hours instead of a maximum of 7,000 times and with a pressure of only 10 pounds for the two teeth instead of 100 pounds for each tooth. Do you appreciate that even then the bicuspid in front of the denture and the molar behind it, during every twenty-four hour period, will have to carry 10 tons of stress for the denture in addition to what falls on their own surfaces? Is it not immediately apparent that the quality of bone by which these teeth are supported, the vitality of the attachments to that bone and the circulation within the teeth are extremely important to their ability to withstand a stress of 60 or 70 tons a week more than they were intended to stand? Dr. Howe has suggested today and pointed out clearly at other times that the quality of the bone, the strength of the attachments and the vitality of the teeth are directly related to the nutritional habits of the patient. Mr. Shultz's teeth may stand the stress if the denture is well planned and made, because his forefathers ate wisely and worked hard outdoors, and because he also has done so. The second patient is Mrs. Rich, of about the same age, for whom we are to replace the same teeth in the same manner. The conditions in her life are very different. She is the wife of a well-to-do merchant. Her children are grown up and away from home. She has much leisure and no physical work. She spends a great deal of time at bridge parties, luncheons, teas, the theater and the like. She never walks if she can ride. She loves the dishes served at parties: meats, bread, cake, pastry, candy and sweet desserts. She is overweight, as soft as jelly and habitually constipated. Her general condition is reflected in her mouth. Her teeth are not of good quality and require much care. Her gums are soft and the circulation in them is not the best. There is quite a good deal of recession. Including meals at home, teas and the like, she will probably masticate some kind of food about 7,000 times daily. On her natural teeth, she might close with an average molar pressure of 25 pounds. Let us give her the same number of closures on the right side of the denture that we gave Mr. Shultz, 2,000 every twenty-four hours, but reduce the masticating force to 5 pounds on the two denture teeth at each closure, an almost unbelievably small force and probably less than is often exerted. Even then, the right side of the denture will transmit 5 tons a day to the abutment teeth. Suppose that each denture is worn six days a week for fifty weeks. Suppose also that to make every conceivable allowance consistent with good service by the dentures, we divide our already reasonable figures by three. Mr. Shultz's denture will still annually transmit to the bicuspid and molar 1,000 tons more force than they ought to have to stand, and Mrs. Rich's denture will transmit 500 tons of such force. What is the probability that the natural teeth can support this additional load, if we suppose that the dentures are well made? That brings us to a differentiation which Fred Miller, of Altoona, Pa., has made, from experience and observation, between excessive occlusion and traumatic occlusion. Excessive occlusion means that a tooth gets more force than it should receive, but that

it is not injured thereby. Traumatic occlusion means that the tooth is injured by the extra force. Excessive occlusion may and often does go on for years without injury to the tooth or supporting tissues if the habits of nutrition and the occlusion are well balanced. When the habits of nutrition and elimination are bad and care of the mouth is neglected, excessive occlusion always causes traumatic occlusion. In Mr. Shultz's case, the excessive occlusion will probably not cause traumatic occlusion; in Mrs. Rich's case, it probably will. Mrs. Rich is likely to lose all her teeth years before she should. The denture may merely hasten the occurrence. Resorption of her alveolar tissues will probably be rapid and extensive, her ridges will probably be sharp, especially on the mandible, and she will be a thorn in the flesh of the dentist who is unfortunate enough to be serving her. Let us close this part of the discussion by saying that the amount of force transmitted to abutment teeth by tooth-borne partial dentures is almost beyond belief until the matter is studied, that it calls for bone and attachments and tooth circulation of the optimum quality, and that these are directly dependent on the patient's habits of nutrition, exercise, rest and elimination. What is good nutrition? Why did Dr. Howe not give us an exact program to be followed, so many spoonfuls of this and pounds of that to be taken with so many glasses of water every so often until the patient is better? To get an answer to that question, I took Dr. Howe's paper to one of the best informed and sanest biochemists of my acquaintance. He said: "We do not know enough to make out one definite program for a large number of people. We know that we should avoid the foods man has denatured and use freely the foods Nature has prepared for us, about as she prepared them and somewhat according to our liking." Sensible nutrition will differ in details for different patients, but it will include liberal quantities of fruits raw and cooked, vegetables raw and cooked, milk and some hard or fibrous food, with small quantities of meat, refined cereals and refined sugar. This program must be regular and continuous. The vitamins, especially vitamin C, cannot be stored in the body very long, and the mineral salts are rapidly used in tissue function. It is comparatively easy to get people to follow such a diet in the summertime, but it is difficult in winter, when it is most necessary. This discussion, which omits many important factors in the subject and merely touches the surface of others, shows that the message which Dr. Howe has brought us is of practical importance to us as makers of partial dentures and to our patients.

USE OF PARTIAL DENTURES AS AN INTEGRAL PART OF MOUTH RECONSTRUCTION*

By WILFRID HALL TERRELL, D.D.S., Pasadena, Calif.

PROSTHETIC dentistry in its earliest form dates back to the time of earliest history. Crude methods for the replacement of teeth are described in the literature, and a number of ancient prosthetic appliances are remaining today among early historic collections as evidence of this work. Some of the ancient methods are today still practiced by the Hindus. Restorative work was done by the Phoenicians and early Egyptians. Considerable attention was paid to the retaining and replacement of teeth by the early Greeks, as evidenced by the writings of Hippocrates and Aristotle. Much earlier than the founding of Rome, in 753 B. C., there flourished in that part

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of middle Italy today called Tuscany the highly civilized people known as Etruscans. They were industrious, intelligent and artistic. They were fond of luxury, and took great care of their persons. At the same time, they were a courageous and energetic people, not only most active and enterprising, in agriculture, in art, in commerce, but also brave in war and hardy in navigation.

The continual trade intercourse between the Etruscans and the Egyptians and Phoenicians accounts for the great influence exercised by the Egyptians and Phoenician civilizations on the Etruscan culture. As to dental art, everything leads to the belief that it was practiced earlier by the Egyptians and the Phoenicians than by the Etruscans. The dental appliances found in the Etruscan tombs,

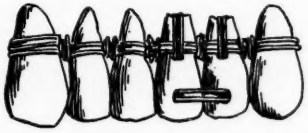

Fig. 1.—Crude device employed in ancient times in prosthetic restoration.

when compared with those of these other countries, show a marked superiority. It is probable therefore that they learned the dental art from the Egyptians and the Phoenicians and subsequently carried it to a much higher degree of perfection.

Here is an analogy to the dental art in America, which emanated from the French and English schools and took on so vigorous a development as indisputably to acquire first rank.

It appears that dentistry had begun to be practiced in Rome prior to the coming of Archagathus, that is, long before the medical profession came into existence. We have clear proof of this in the law of the twelve tables, written in Rome, 450 B. C., wherein we find mention made of teeth bound with gold.

Figure 5 shows a prosthetic piece made of laminated gold wire, soldered together and carrying two lower central incisors and a lateral incisor. This ingenious appliance was found still adherent to the mandible of a skeleton in a tomb which, according to the archeologist Dalli Osso, belongs to a period between the third and fourth century B. C. From the nature of the objects in the tomb found near the skeleton, for example, a necklace and perfume vessels, it was quite evident the skeleton bearing the prosthetic appliance was that of a woman.

Guy de Chauliac, the greatest surgeon of the middle ages, was born about 1300 in a little village in France which still bears his name. In his writings, he says, "If the teeth fall out, they may be re-

Fig. 2.—Restorative work of ancient Egyptians.

placed with the teeth of another person, or with artificial teeth of ox-bone, fixing them in their place with a fine ligature; and such teeth are serviceable for a long time." Without the slightest doubt, dental prosthesis was practiced neither by doctors nor surgeons but by dentists of that day. In short, dentistry had become a specialized profession.

For several centuries, there was apparently little progress made in the field of restorative dentistry. At the end of the sixteenth century, Fabricius of Aquapendente writes, "Artificial teeth are made of ivory or of bone (for example, the tibia of the ox) and are fastened by gold wire. One has recourse to this means especially to correct the bad appearance

and the defects in speech deriving from the loss of front teeth."

Pierre Fauchard, the founder of modern scientific dentistry, was born in Brittany about 1690 and died in Paris in 1761. His celebrated work, "Le Chirurgien Dentiste," published in 1728, marks a new epoch in the history of dental art. The most renowned physicians, surgeons and anatomists of the times testified their admiration for Fauchard's work, which was translated into German in 1733 and appeared in two editions in French, in 1746 and 1786.

Fauchard says, "The experience which I have acquired through an uninterrupted practice of forty years has led me insensibly to the acquirement of further knowledge and to the modification of what seemed to me defective in my earlier years. I offer to the public the results of my labors and of my studies, hoping that they may be of some use to those who wish to exercise the profession of surgeon-dentist."

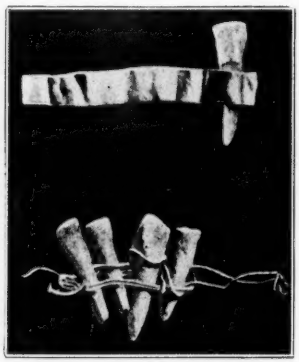

Fig. 3.—Use of gold in prosthetic work by ancient Egyptians and Phoenicians.

That dentists before the time of Fauchard published little concerning their profession was probably due to jealousy lest the fruits of their labors be utilized by their competitors. The trend of dentistry began to change at this time, and today we have learned that those who give most receive most.

One of Fauchard's greatest achievements consisted in the improvements offered by him in dental prosthesis. He minutely described the methods to be followed in repairing the dental apparatus in every possible case and of whatever extent. The materials most used at that time in dental prosthesis were human teeth, hippopotamus tusks, ivory of the best quality and ox-bone. Figure 7 shows his illustration of a partial lower and a full upper denture.

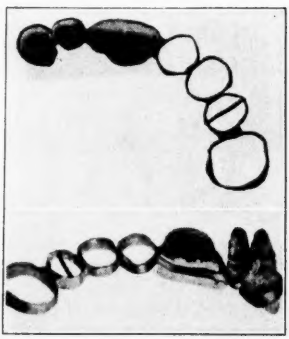

Fig. 4.—Occlusal and lateral view of gold appliances used by early workers. Two teeth had been extracted.

Fauchard says, "Not long since, I had to renovate a set of this kind made by me more than twenty-four years ago and worn by the owner to the greatest advantage." He was not content merely with the mechanics of his cases, but studied also the appearance, as he used enamels to impart the tooth hues and he also imitated the natural color of the gums.

The use of porcelain in prosthetics was developed by Dubois de Chamant shortly before 1800. As neither the vul-

canizing nor the casting process had been developed at this time, it is evident that the development of modern restorative dentistry has largely come about within the last century, and we are at present in the midst of a developmental and transitional period, unhandicapped by lack of materials and instruments and yet seeing the need for improvement in both. We are now living in what is probably the most interesting and opportune moment of dental development. Some feel that everything has been worked out for us and now all that is left for us is to utilize it to our advantage. We have at our command opportunities for the greatest advance that dentistry has ever seen, though many seem to feel that they have reached a point beyond which advancement will be impossible. Progress

Fig. 5.—Prosthetic piece made of laminated gold wire, carrying two lower central incisors and lateral incisor.

can be made only when we have a goal that is idealistic and which is always in advance of our present attainments. Since our minds guide our hands, growth can come only through inspiration and study.

Figures 8-10 serve to illustrate the diversity in types of partial dentures in use at the present time. Many have been unsatisfactory from the start and the remainder have served their day. Others took their places and made the patient comfortable and happy at the time. I wonder how long these will continue to function efficiently and comfortably. We should give thought to our designing, our selection of type and our method of construction, for each particular case, also looking into the future as to what will happen in that mouth. How long should teeth last? Do our patients have a right to expect a restoration to last them the rest of their lives? Caries, abrasion, resorption of ridges, the health and hygiene of the mouth and many other conditions are partially or wholly beyond the dentist's control and all influence the life of the denture and the time that those mouths can continue without repair or reconstruction. Fauchard, in speaking of the denture which the patient had worn so successfully for

Fig. 6.—Pierre Fauchard, the founder of modern scientific dentistry.

nearly twenty-five years, said that he had had only three patients whose mouths were in a condition for such a restoration and he had made similar dentures for all three and all had been successful. Success lies in knowing when and where to apply certain principles and that rare ability of good judgment in deciding what is the best procedure. No rule of thumb can do this for us though there are certain guiding principles which can be applied.

A few of these, which have but few exceptions, follow:

1. Tissue-borne saddles should cover all of the available stress-bearing area.

2. Tooth-borne saddles in small spans may be limited in size.

3. Isolated bicuspid abutments with saddle areas posterior to them as distal extensions should not have occlusal rests.

4. Some type of indirect retention should be used in connection with all distal extensions.

5. The gingival borders of the teeth should never be impinged on and should always be cleared at least from one-sixteenth to one-eighth inch.

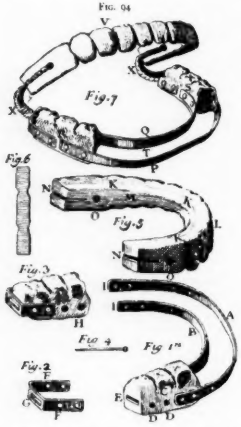

Fig. 7.—Partial lower and full upper denture made by Fauchard.

6. Palatal bars should curve backward crossing the palate at the junction of the hard and soft palates. (This places them beyond the range of the tongue and posterior to the torus palatinus, allowing them to be placed against the soft tissue, without danger of settling against the hard area.)

7. If attachments are used, cavities should not be cut deep enough to endanger the pulp.

8. Internal attachments in connection with distal extension saddles should be of an adjustable flexible type used in conjunction with a carefully planned means of indirect retention.

9. A mesiodistal grip clasp should not be used on a distal extension saddle, if attached rigidly to the saddle or the appliance.

10. If clasps are used, they should be of a type covering the least possible tooth structure and should also be flexible in their grip and properly paralleled.

11. If clasps are used, they should, if possible, be kept well up from the cervical margin of the tooth.

12. If occlusal rests are necessary, smooth polished slots should always be prepared, ready for their reception. They should be as shallow as is consistent with the strength of the rest.

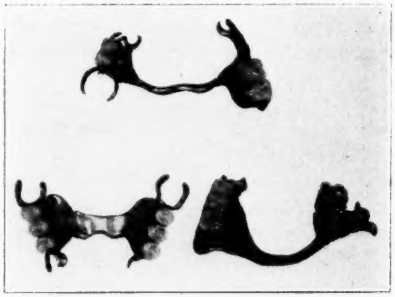

Fig. 8.—Types of partial dentures in use at present time. These and the dentures shown in Figures 9-10 indicate the diversity of appliances in use today.

13. Saddles over recent extraction areas should be made of rebaseable material.

14. One type should not be made to serve as a remedy for all cases.

Let us think first of the mutilated mouths as we see them with a number of teeth missing and part of the natural dentition still in place. Our first thought

should not be the one which is usually paramount in the minds of both the patient and the dentist, and that is as to how the partial denture or bridge shall be made. This should rather be the last than the first, but it will not be unless the dentist insists on it, for the patient does not realize what has happened to the mouth since the teeth were lost. As a rule, the patient is anxious that the spaces be filled for function, comfort and esthetic reasons, and the dentist is anxious that this be accomplished in the quickest and easiest manner in order to collect a fee for partial dentures or bridge work as the case may be. Severe traumatic occlusion exists in practically

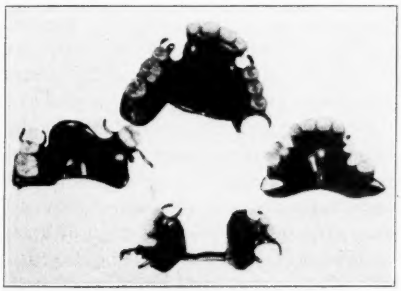

Fig. 9.—Types of partial dentures in use at present time.

all partial denture cases prior to reconstruction. Why is it that so many partial dentures are followed by full dentures? If it is granted that the natural crowns of the teeth are properly guarded and protected against the encroachment of caries, for what reason are the remaining teeth lost? There can be only one answer, and that is loss of the supporting structures. Here, we need to refer to the knowledge that has been gained by the periodontist and the orthodontist on this subject. We find that the principal cause, aside from improper restoration and the health and hygiene of the patient, is traumatic occlusion, due to malposition of the teeth, caused by loss of contact, movement due to an improper occlusal restoration, loss of either approximate or opposing teeth, the presence of teeth not in line with axial stress, or failure to have orthodontic work done if malocclusion exists.

There is far more to orthodontia than the esthetic results, and a study of occlusion should be begun in young patients. In this study, we cannot deal with what should have been done, for we must accept the conditions as they are and within limits do that which will assure the best

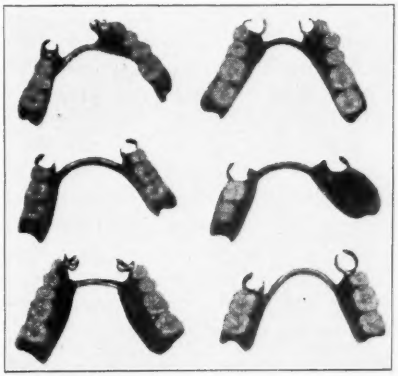

Fig. 10.—Types of partial dentures in use at present time.

results. Orthodontic measures are indicated even in some adult cases, but such cases should be referred to a competent orthodontist for treatment. There is no age limit in this work. To have perfect coordination of all parts is an ideal which exists only in the imagination, but we must have that picture firmly fixed in our minds if we are in any manner to approach it. This study can best be carried on by studying skulls from which the teeth have not been lost or study models in fine occlusion. Loss of

teeth, drifting and abrasion also cause closure of the bite in many cases. Do not misunderstand me: not all patients who have need of partial dentures must have the bite raised and the occlusal surfaces of all teeth coordinated, but each should be studied and the ratio to normal should be ascertained. It is possible to do all such work directly in the mouth without the aid of any instruments, but it is a much more difficult method and often lacks certain of the refinements. Lack of instruments or a knowledge of their use need not prevent any man from doing this work, but the more he does, the greater will be his desire to introduce the greatest possible refinements. This is not an impractical ideal that is only for the wealthy, as many suppose, but is a means of doing a greater service for those conscientious patients who expect of their dentist that he will give their mouths his best service and thought at all times. A dentist should sell his patients nothing, but he should place himself in a position to deliver that which is best. If we create a desire, we must be able to deliver, but we also must be very careful that we do not create a desire impossible of fulfilment and ending in disappointment and failure, as it is sure to do.

The incorporation of balanced occlusion into our restorative work means little change in our methods. What it does mean is that we must change our point of view. We must be able to make a mental picture that reaches beyond the individual units, namely, the occlusal-restoration of natural teeth or the artificial substitutes, a picture that includes all the units working together in harmony. The establishment of functional occlusion of the teeth should be assured before partial dentures are constructed or at the same time if the work is done on an instrument.

Following is a series of steps which may be taken in the study of difficult cases: 1. Taking of complete dentocoll impressions, plaster impressions or sectional compound impressions of the upper and lower arches. 2. Pouring of study models in some quick-setting, hard cast stone. 3. Mounting of the casts on a fully adjustable controlled articulator by means of accurate centric checkbites. These may be obtained by means of an extra-oral gothic arch tracing, which acts as a guide. 4. Setting of the instrument to the patient's movements which have been recorded in the patient's bites. 5. Study of the movements and what is necessary for the attainment of occlusal coordination. 6. A study of the roentgenograms in conjunction with models, paying particular attention to periodontal disease; also, by means of the roentgenograms and study models, a study of the existing dentures, inlays, etc., in the mouth. The roentgenograms are marked for carious areas to be eliminated, teeth to be extracted and any points for necessary surgery for the elimination of areas of infection. 7. A study of the direction of occlusal stresses and harmony of cusps in centric protrusive and lateral positions. 8. A study of the relation of wear on the anterior and posterior teeth. 9. A study of the facial dimensions of the patient. 10. A determination of the necessity for opening the bite if it is a "closure" case. 11. A determination of the patient's attitude toward dentistry and the care of the mouth, and as to whether he is of a neurasthenic type. A desire on the part of the patient for the work and his absolute cooperation are necessary for success. The patient must have an appreciation of and a desire for precision and be willing to sacrifice to this end. Not to heed the foregoing points spells failure before the case is started.

Having given consideration to the mouth in its entirety, we shall next consider the selection of the type of partial denture for restoration of edentulous spaces and then come back to the refinements in the coordination of the occlusion.

Selection of the partial denture is based on (1) conservation of tooth structure, which should be considered of great importance; (2) the strength of the periodontium of the remaining teeth; (3) the type of occlusion of the opposing teeth; (4) the size and type of ridge tissue; (5) the condition of the tooth, tissue or combined support.

Internal precision attachments are an excellent means of attachment when caries, inlays, etc., are present in the majority of the abutment teeth. External clasps of a correct design may be used when little caries or tooth destruction is present. When clasps are used, they should be paralleled by means of a clasp surveyor and made with the same precision as an internal attachment case. A minimum of tooth structure should be covered and there should be sufficient flexibility to prevent strain on the natural teeth.

The last considerations are the final refinements in occlusal coordination of the entire mouth including the teeth on the partial dentures. Each case should have at least unilateral tooth balance in lateral positions and bilateral tooth balance in centric position. Bilateral tooth balance in lateral positions is an ideal which is rarely attainable with natural teeth and is not so important as it is with full dentures. Bilateral tooth balance in centric relation is a positive essential. There should be contact in the lateral position thrown to the working side of all the buccally inclined planes of all the buccal cusps of the lower teeth simultaneously with the lingual inclined planes of the buccal cusps of the upper. This also includes the cuspid teeth which act as the guides. This prevents excessive lateral strain on any one tooth when moving to the lateral position.

The greatest importance of bilateral tooth balance is in centric position when the teeth are in contact. Probably the greatest traumatic injuries are caused by failure to recognize this fact.

Points to be observed in tooth forms are as follows:

1. The depth of the sulci must be equal, that is, functional contact in centric relation should bring equal pressure on all teeth.
2. The inclined planes should be parallel to the direction of movement.
3. The buccal and lingual cusps of the teeth on both sides of the mouth should come into the respective sulci of their opposing teeth when the mandible is closed in centric relation in order to establish a functional balance which produces no periodontal strain.
4. The direction and inclination of the inclined planes must be modified from the centric form by the introduction of the lateral movements of the mandible so that there is simultaneous and equal contact.
5. These angular planes and cusps should then be modified to copy nature in her most refined and efficient tooth forms.
6. Supplemental ridges and developmental grooves should be accentuated, marginal ridges retained and deep sluiceways for the food made between the major cusps and between the cusps and the marginal ridges.
7. All cusps, both major cusps and ridges and minor supplemental ridges, should prevent convex surfaces.

By deep sluiceways and convex cusps, efficiency is increased in the cutting action of the teeth as they present a series of line and point contacts with means of

escapement for the food. Protection is afforded to the teeth themselves by the decreased pressure required for cutting the food. A balance so developed will give increased efficiency, but, most important of all, it prolongs the life of the teeth from the fact that the periodontal tissues are kept healthy by moderate stimulation instead of being destroyed or becoming diseased by overwork due to trauma and lack of evenly distributed pressure.

The science of dentistry has broadened in scope from the simple operation of stopping toothache and of filling cavities in teeth to a highly specialized profession of which we can be justly proud. A few of the specialized branches are prosthodontia, orthodontia, periodontia and exodontia.

If we are general practitioners, we can learn much from the work that has been done in the specialized branches and profit by it. If we limit our work it is also important to familiarize ourselves with the work that is being done because we are all working in the same mouths, and there is a correlation of cause and effect between many procedures. If we are proud of our profession, we should do all in our power to increase public confidence. We should be willing to shoulder responsibilities when confidence is placed in us and see to it that we live up to that confidence, giving each case serious thought and study before applying our utmost skill to the constructive work. If we make mistakes in judgment, let us profit by them, place them in our mental notebook and not forget to review them occasionally. We all make mistakes, but we should never make the same mistake twice.

We should not be content with the path of least resistance; for the one who progresses, who gives the greater service to mankind and who gets the greatest joy out of his work is he who is not afraid to face difficult problems and who is willing to devote additional time to study that he may see them through to successful completion.

THE ROENTGENOGRAM IN A PUBLIC HEALTH SERVICE

By ARTHUR F. WEEKS, D.M.D., Portland, Ore.

THE dental profession has accepted the guardianship of the public health. I do not know who it was that first made this statement, but we have seen it many times in our literature, especially in articles treating of the relation between dental and systemic conditions. I am not sure that the dental profession *has* accepted this responsibility, but I am sure that the responsibility has been *placed upon* the dental profession by many medical authorities.

It must have been about a score of years ago that Charles H. Mayo made a statement to the effect that the next great step in preventive medicine was to be

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taken by the dental profession. This was immediately after the first publication of the focal infection theory, and there was at once a wholesale and ruthless attack on the teeth. Every one here who was in practice at that time has had the experience of having a patient come in with the statement that his physician had ordered all of his teeth out. Patients themselves became possessed of the idea that their teeth were the cause of all their ailments and came to us demanding that they be removed. In large numbers of cases, it was discovered, probably after the extraction, that if any examination had been made, it had consisted of peering into the mouth, and, because of certain dental restorations or nicotine stains on the teeth, all the teeth were condemned. We are all familiar with the story of the physician who, on making this careful examination, demanded removal of all the teeth and had the patient oblige by immediately disgorging full upper and lower dentures.

The natural consequence of these irrational procedures was that the desired cure was not effected and there was a reaction in the opposite direction.

Thereafter, with the realization of all concerned that mistakes were being made, the better physicians adopted the procedure of sending patients in whom they suspected a focus of infection to a dentist, with instructions to have an examination made and any foci removed. This was sound practice; but again there were many disappointments. Frequently, the fault could still be laid at the physician's door; for while the mouth may have been carefully examined and infection eliminated, infected tonsils, sinuses, intestinal tract, prostate or cervix may have been overlooked; any of which may have been a more probable source of the condition from which relief was being sought. Of that, we can wash our hands, although an uninformed public does not so readily absolve us. But the dental profession also was and is derelict in its responsibility, assumed or placed upon it. Physicians have referred patients to the dentist after making their examination carefully and thoroughly. The dentist, in far too many instances, has, with inadequate examination, given the mouth a clean bill of health, while there were actual or potential foci present of which he had no knowledge. In far too many instances, when a careful dental examination has been made, actual or potential foci have been allowed to remain, either because the dentist, through failure to recognize and interpret the conditions when shown, or a lack of belief in the focal infection theory, has refused to recognize them, and has reported to the patient or physician that there was nothing in the mouth that could be related to the systemic condition. The report has been accepted as authoritative and, when improvement in the patient's condition has failed to materialize, physicians and public have had their faith shaken not only in the focal infection theory as far as dental foci are concerned, but also in the ability of the dental profession to cooperate with them.

The foregoing is not intended as an indictment, but rather is given because of the belief that future success is built upon past failures. I believe that the dental profession does accept any reasonable responsibility that is placed upon it, and believing that the dentist is second only to the physician in any public health program, I am attempting to show the important position that radiodontia holds in any public health program.

Radiodontia, of course, implies the intensive use of the roentgen rays in dentistry. It would seem that, at this advanced age, it would be time wasted to

attempt to point out the worth of this most valuable of diagnostic aids. To many, it is a waste of time except that repetition emphasizes certain facts. To those who have not as yet formed the habit of using the roentgen rays intelligently and intensively, I hope to make a suggestion or two that may enable them to give their patients a more intelligent health service.

All of the patients that come under our care may be divided roughly into two classes: either they are suffering from some systemic condition from which they are in search of relief, or they are well and healthy as far as they know, and are simply going through the routine of having necessary repair work done on the teeth. For convenience, we might call these medical-dental cases and dental cases.

In whichever class they may belong, we are still responsible for their health as far as the oral cavity goes, and the focal infection theory must ever be held in mind. I shall make no attempt to expound or defend the focal infection theory. I will only say to any who are either in doubt as to the soundness of the theory or choose to reject it that, until the time comes, if it ever should, when the focal infection theory shall be exploded and disproved by men of knowledge and ability equal to that of those who have evolved and now advocate it, they are trifling with the health and lives of their patients in an unjustifiable manner. The best statement of the case that I can make is to repeat the words of Edward H. Hatton of Northwestern University, in discussing a paper on focal infection: "Although the case was not yet proved, for focal infection, this is no excuse for the dentist to allow mouth infection to be present, because, although it cannot be proved that this is definitely a cause for systemic trouble, it may be."

A prudent man will not stay in a room with a scarlet fever or meningitis patient on the theory that he is not sure that he will contract the malady, and that, if he should, it might not be fatal. Neither can the dental profession, having accepted the guardianship of the public health, gamble at this time on the truth or fallacy of the focal infection theory. The inference is clear. We must discover and remove all possible and potential foci in those patients who are ailing with some disease possibly traceable to a focus. In the class coming in for routine repair work, all actual infection should be removed. The so-called questionable areas, which many believe in tolerating in the absence of symptoms indicating the possibility of a focus, should be noted and the patient advised thereof. And all conditions that might, if neglected, eventually be responsible for a focus of infection should be discovered and corrected.

All of this may seem a lengthy prelude to what we set out to talk about, radiodontia; but if the foregoing has no foundation, then the roentgen rays are of comparatively little value to the dentist and could be reserved for the location of a broken root, or an attempt to find the cause of an obscure pain when all other methods have failed. Granting the soundness of this reasoning, we are ready to consider the treatment of the patient. If we are to proceed intelligently, we should first recall two fundamental truths: 1. The first essential of every successful treatment is diagnosis. 2. The first essential of every diagnosis is examination.

Therefore, the first factor in successful treatment is examination. I believe it is well worth our while to take the time to consider the manner in which we take this first step on which the health of our patients depends as far as

it is given to us as dentists to control the conditon.

What are the means of examination of the mouth? Briefly, they are instruments such as mirrors, explorers and floss; vitality testing, both thermal and electrical: transillumination; the case history, including the health picture; consideration of esthetic and financial aspects, and the roentgenogram.

All of these are links in the chain and no examination is thorough without using them all; but the one which gives the most information and the one which is most frequently omitted is the roentgen-ray examination. I am willing to challenge any man to make his ordinary routine examination using all of these means except the roentgen rays, and then independently have a roentgen-ray examination made omitting the other methods, and in more than 75 per cent of cases, and I think in 90 per cent, unless a man were using more extraordinary care than is customary, the roentgen-ray examination will show conditions that have been overlooked. The practice of testing teeth for vitality and relying on the results when searching for focal infection is bad. It is possible to get a response to a vitality test in a pulpless and infected tooth, and there are times when it is impossible to get a response from a vital tooth. Transillumination, while helpful in certain cases, is probably the least reliable of all methods. Examination with mouth mirror and explorers has limitations even in the examination of the exposed portion of the tooth. The roentgen-ray examination too has its limitations, but it reveals more than all of the other means put together, many of the conditions being entirely impossible of discovery otherwise.

In the class of patients searching for the cause of a systemic disorder, particularly when referred by the physician, nothing less than a complete roentgenographic examination is indicated or justified. The tooth apex, periodontium, where the apical third or bifurcation of the root is involved, broken roots and other residual areas and impacted teeth are all potential foci of infection.

Two or three years ago, Frank Mihnos, of Portland, presented a study of a large number of roentgenograms which showed a surprisingly high percentage of pathologic conditions. Thereafter, my associate, H. C. Fixott, and I made an exhaustive study of 1,000 complete roentgenographic examinations. All of the cases used in obtaining these figures were complete roentgenographic examinations of from fourteen to eighteen films. They were taken from our files as they came, and were not selected, except that we excluded entirely edentulous cases and cases of children where there were still a number of unerupted permanent teeth. They included cases that had as many as thirty-two teeth present, and as few as ten or twelve. There were cases that showed practically no pathologic condition, and those in which complete extraction was indicated. They represented mouths that had received exceptional, average, mediocre and poor dental attention. There were mouths of patients in all conditions of sickness and health. If there was any class not included to any extent, it was the indigent and underprivileged class. The individuals of this group, because of this very condition, were not in a position to obtain proper medical and dental attention. Were there more of this class included, it is evident that the percentages of pathologic conditions would have been raised. As it is, we believe that these cases represent a cross-section of the mouth conditions in our community and are a fair index as to the conditions a

dentist has reason to suspect in the mouth of the average patient.

Without going into detail or presenting an array of figures and tabulations, it is worthy of comment that this study revealed that 67.5 per cent of all of these 1,000 individuals had teeth showing evidence of periapical infection; 4.9 per cent who had pieces of roots or other termed roentgen-ray negative, making a grand total of 72.4 per cent of all who had pulpless teeth which must be considered in any health examination, and 29 per cent who had pieces of roots or other residual areas of infection in the edentulous areas. Statistics compiled at the Mayo Clinic show a slightly higher percentage even than this. Five per cent were shown to have impacted teeth, not all, of course, demanding extraction, but nevertheless calling for consideration. All of these must be revealed if we are to justify our position as guardians of the public health. If we overlook one focus of infection because of incomplete examination, we will have broken a link in the chain of complete physical examination; we will have trifled with our patient's health, and we will have been unfaithful to our trust as guardians of the public health. We may not think that there is any focal infection present, and there may be none, but we cannot match our thoughts against the information that may be obtained by using the roentgen rays. Should the roentgenogram show that things are precisely as we had anticipated, the negative report is just as valuable and just as much of a protection to all concerned as is a negative Wassermann reaction, a diphtheria culture or a gastro-intestinal examination that fails to show an ulcer or malignancy.

In the class of patients who are simply undergoing a periodic dental examination and as far as we know are in perfect health, the responsibility is just as great if not greater. One of the greatest compensations that comes to us is the knowledge that we have assisted a patient to regain his lost health. But guardians of health will so carefully watch over the mouth that the condition of the teeth and surrounding structures will never be the cause of systemic disease. While not so spectacular, and often less appreciated, the dentist who cares for a patient from childhood, and does not allow conditions to progress until they become a menace, or who, aquiring a healthy patient, cleans up infected areas as a prophylactic measure, warns his patient of questionable conditions and allows no new pathologic invasion, is rendering an infinitely more valuable service than he who allows foci to remain or develop, and then, having allowed the health to become impaired, uses heroic measures to bring about a seemingly miraculous cure.

To the conscientious dentist, preventive dentistry is the most alluring and satisfying of all branches of our work. Here again, ultimate success or failure depends on the same essential primary step mentioned before, adequate examination; and here again, the roentgen rays are the most valuable adjunct we have, and the one that is the least used in proportion to its possibilities. Just as in the case of the medico-dental patients, the roentgen rays are so frequently used only to examine doubtful areas, so, in the study of dental cases, they are often dispensed with entirely.

Referring again for a moment to the surveys made of conditions shown in roentgenograms, we find that 90.3 per cent of all individuals represented had carious areas in one or more teeth, and that, in the mouths of these 1,000 pa-

tients, there were carious areas in 15.9 per cent of all of the 25,112 teeth present. The sequelae of caries is well known: progressive destruction of tooth structure, pulp irritation and pulp degeneration and death, followed by periapical infection with the ever present danger of a focus of infection developing. Not only numberless cases of beginning caries, but frequently caries to a degree involving the pulp is found in roentgenograms that have been entirely overlooked in exploration. The introduction of the bite-wing film by Dr. Raper has materially increased the usefulness of the roentgen rays in this respect. In using these films, the rays penetrate the tooth almost at right angles, giving a less distorted view of the crown than when the rays are directed at the apex of the root.

Instances of discovered caries which had been overlooked by other means are numerous. I should like to cite two striking instances:

M. M., a young man, a student in Oregon State College, during a vacation had visited his dentist for examination. This dentist is a conscientious man, of average skill and ability. The teeth were cleaned and one or two alloy fillings inserted, and patient was dismissed for a six-month period. The same day, while he was in our office, a series of bite-wing films were made, with no idea of checking the work, but in experimenting on technic. The films disclosed carious areas in seven teeth. The cavities varied in size from small beginning caries to one that all but involved the pulp of a molar.

A. H., the young daughter of a dentist of more than average ability, was seen by chance when I was in her father's office. The daughter, who had been suffering with a dull toothache for some time, was in the chair. The dentist was carefully exploring the teeth and using dental floss. Finding no indication of caries, he was of the opinion that there must be a dying pulp in the lower first molar, which was carrying a large inlay. At my suggestion, I took the patient to my office and made roentgenograms of the teeth in this and other areas. We found the cause of the ache to be a cavity on the distal side of the second bicuspid adjacent to the suspected molar. This cavity nearly if not actually involved the pulp, and yet even after we knew that it was there, an instrument could not be hooked into it.

Both of these were confronted with the probability of losing the pulps or the teeth. A roentgen-ray examination six months before would have insured the saving of these teeth and their vitality; a year before, would probably have shown moderate cavities. If the public health is to be guarded, these conditions which eventually favor infection must be discovered in their early stages.

Guy S. Millberry, in his article "Outstanding Achievements in Dentistry," devotes considerable space to the discussion of public health and preventive dentistry. He is speaking particularly of preventive dentistry for children, but it is equally applicable to all practice. He says:

Unless the dentists take the lead in developing this program, other social agencies will soon step in and assume its direction, for the constant educational effort on the part of many individuals and groups in encouraging the care and preservation of the teeth has made the American people tooth conscious.

Having stimulated a desire, shown the imperative need, pictured the dire results of neglect, what is to be done about it?

There are two distinct activities, education and service. The former is being quite well taken care of, but the latter is just as thoroughly neglected.

Pyorrhea, in its early stages, is often revealed in roentgenograms before it can be revealed in the mouth. Merritt and Pollia state that the beginning stages of pyorrhea are apparent in the roentgenogram before there is any discoverable irritation of the gum tissue. The bite-wing film is of especial value here. In the films taken at an oblique

angle, to obtain a view of the apical region, the crest is distorted, which leads to mistaken readings in the interproximal space. The stratum durum, the white line that borders the normal alveolar crest, becomes more radiolucent and is lost, the septums become notched and flattened. The black line between tooth and bone becomes wider, tapering from the cemento-enamel junction toward the apex. Following this comes the familiar inflammation of the soft tissues, suppuration and extensive destruction of the process with all the possibilities of absorption of toxins, or, if the teeth are retained, loss of the ridge, which makes denture construction so difficult. The survey shows that 50 per cent of patients have some degree of alveolar bone destruction. Early detection of this condition is certainly a high type of public health service.

Rough overhanging fillings or overside crowns are revealed in the mouths of 42.4 per cent of patients. In these septic basins, all manner of micro-organisms are incubated.

Deposits of secondary dentin, hypercementosed roots, supernumary teeth and various types of bone disease all may be indices of systemic disease, and all are revealed by the roentgen rays. Pollia has pointed out at length the relationship between these conditions.

As stated before, the field of prevention is the most alluring of all to the dentist desirous of giving the best service. Preventive dentistry cannot be practiced without the intelligent use of the roentgen rays. In the light of present day knowledge, the method of examining the mouth even for caries without complete roentgenograms is just as slipshod as it would have been a few years ago to neglect to explore the sulci and interproximal spaces, simply looking for cavities that had caused the tooth to lose its contour and that appear as gaping orifices.

Whether considering a dental or a medicodental case, modern good practice demands complete information, and no examination can possibly be complete without an intelligent use of the roentgen rays. If the dental profession is the guardian of the public health, and I take it that we gladly accept the responsibility as far as the public health is dependent on oral health, then every dentist, physician and layman should recognize the truth of a statement which I have borrowed from my associate, Dr. Fixott, that "the roentgen ray lights a pathway to health."

PREANESTHETIC MEDICATION*

By C. H. BURMEISTER, D.D.S., Cincinnati, Ohio

THERE is probably no one anesthetic or method of anesthetization that can be used universally in preference to all others. It is only by careful selection of the anesthetic and the method of administration that the desired surgical results are obtained. Any advantageous drug or drugs which can be used alone or in combination, or as a preliminary means to either local or general anesthesia in major or minor surgery, may be employed provided the drug has no toxic effect on the patient. Many patients would rather have a major or minor operation than have a tooth exrtacted or any other type of dental work done. This may be due to the severe pain that they have had at some previous time, or an assumed attitude which is exaggerated and magnified each time a visit to the dentist is necessary. Either one can be controlled and overcome, if these patients are handled properly. Preliminary medication is especially indicated in the hypersensitive, hysterical and neurotic patient, whether the operation is the preparation of sensitive cavities in teeth, extraction of teeth or a major or minor surgical measure. By the use of preliminary medication, this type of patient is relieved of fear and apprehension, and is therefore more like the normal patient. Whenever possible, I do not use morphin or its derivatives, as the desired results can usually be obtained from the use of hypnotics.

Any drug which will produce sufficient hypnosis to spare the patient the dread of an operation without, at the same time, endangering his welfare or creating difficulties in local and inhalation anesthesia, must be welcomed as a desirable adjunct to preanesthetic medication. A patient's reaction to anesthesia and surgical intervention is the total of all stimuli that reach the brain. Dental and oral surgeons are apt to minimize the effect of the emotional and psychic phenomena on a patient about to undergo an operation. What is a commonplace experience to anesthetists, dentists, surgeons and hospital attendants is an adventure of terrifying and surprising magnitude to a great many patients. If the patient is hospitalized, the preparation for operation, the preliminary hypodermic, the change of body apparel, the trip on a stretcher, the handling of instruments, the "scrubbing up," and finally the presence of the mask over the face until the patient thinks he is suffocating, all have a corresponding reaction, in many cases out of all proportions to the surgical trauma inflicted in the operating room.

What, then, would be the ideal state before, during and after the operation? First, of course, the patient must be anesthetized, but the anesthetic should not

*Read before the Section on Oral Surgery, Exodontia and Anesthesia at the Seventy-Fourth Annual Session of the American Dental Association, Buffalo, N. Y., Sept. 13, 1932.

bring added terrors, and be a hideous nightmare as the worst part of his operative experience. In the ideal state, the patient will drift into sleep gently, quietly and naturally. No longer will the patient be plunged into a seeming eternity after a short period of consciousness, and therefore, terrified, struggle against suffocation. Anyone who has been put to sleep consciously will recall the experience only with repugnance. The drug or agent employed should act without irritation to the organs of the body in its administration and elimination. It must not add to the hazards of the operation by effects of its own, such as ether produces on the air passages, chloroform on the liver, and cocain and procain on the nervous system.

In the past three years, the derivatives of barbituric acid have been used with a great deal of success in the United States and Europe. Sodium amytal has been used in more than 400 cases in my office and hospital practice, orally and intravenously, with good results. From a review of the literature, it is unquestionably less toxic than other barbiturates, and it is an asset to the general practitioner and oral surgeon.

I do not wish to convey the idea that in all cases in office practice, premedication is employed, but for minor surgical operations, such as multiple extractions, removal of impacted teeth and cysts and correction of fractures, sodium amytal is used routinely in office practice, preceding either local or general anesthesia. A neurologist of Cincinnati controls many of his patients who visit his office by using barbiturates, either by mouth or in small doses intravenously. In this manner, he is usually able to overcome inhibitions, and obtain a complete case history.

Amytal, which is iso-amyl-ethyl-barbiturate, has been used for hypnotic and sedative purposes, since its synthesis by Shonle and Moment.[1] Sodium amytal which is the sodium salt of iso-amyl-ethyl-barbiturate, has been used orally and intravenously in certain scientific laboratories for more than ten years.

EFFECT ON CENTRAL NERVOUS SYSTEM

The state of the central nervous system is an important factor in determining variations in the intensity of effect and the persistence of action. Sensory and motor excitement act antagonistically, while depression acts synergistically with sodium amytal. In other words, the rapidity with which we pass through the predormant stage is influenced by three conditions: the rapidity of falling asleep, the individual capacity for sleep and the fatigue sensation causing sleep, while the counteracting influence would be noise, nervousness, fright, etc., and, in dental or surgical cases, it will be practically nervousness and fright altogether.

As the neutralizing effects of sodium amytal on the toxicity of anesthetics of the cocain group are of central origin, they should be considered under the central nervous system. Since the introduction of cocain into surgical practice as an anesthetic, many instances of toxic action of the drug have been observed. Accordingly, numerous substitutes for cocain have been offered with the idea of avoiding the undesirable effects of local anesthetics, and, as a result, procain has found extensive use.

The use of a sedative, as a preliminary to local and general anesthetics, has many advantages. Lundy of the Mayo

1. Shonle and Moment: Some New Hypnotics of Barbituric Acid Series, J. Am. Chem. Soc., 45:243, 1932.

Clinic,[2] and Isenberger,[3] of the University of Kansas, found that it prevents toxic reaction from procain and cocain. Tatum, Collins and Atkinson[4] have demonstrated that barbital prevents acute cocain intoxication in animals. Loevenhart[5] and his associates have also shown that procain intoxication is prevented by the use of sodium amytal. In experiments performed by Isenberger, animals were first given this agent and then were injected with 20 per cent solution of procain intravenously in large amounts without causing convulsions. Animals not given a sedative went into convulsions on ingesting very small amounts. After performing these experiments on animals, then on patients of known susceptibility to cocain and its related group, Isenberger reached the conclusion that sodium amytal in proper doses will protect against convulsions caused by procain, but will not prevent the depression brought about by overwhelming doses of this group; and he says that sodium amytal, with properly controlled artificial respiration, offers the greatest hope for saving life in cases of severe poisoning by procain.

This definitely proves that it counteracts the toxicity of procain and makes it ideal for prevention of a reaction in susceptible patients. Even though procain is less toxic than other anesthetics, there are always individuals who have idiosyncrasies for certain drugs, even though the technic for producing anesthesia is faultless. Syncope, which is not uncommon under local anesthetics, is due to reflex inhibition of the cardiac and respiratory centers by fear, the action of the anesthetic or both. As sodium amytal counteracts the toxicity of procain and cocain, and allays the fear that the highly nervous and hysterical patients have of operative procedure, it is an ideal preliminary medicament to this method of anesthesia. It does not in any way affect the bleeding time and will control any type of convulsions, including human rabies and tetanus. It is also specific against strychnin poisoning.

EFFECTS ON METABOLISM

Basal metabolism is slightly lowered after large doses of sodium amytal, but it usually remains at a constant level despite a fall in body temperature of 2 or 3 degrees. The fall in body temperature is rapid and remains at this level for about three hours. Deuel, Chambers and Milhorst[6] found the effect of amytal on basal metabolism of animals to be a slight lowering, but it usually remained at a constant level even though there was a fall in body temperature of from 2 to 3 degrees. It is a question whether the administration of sodium amytal decreases the basal metabolic rate below that of normal sleep. The absolute output of urea may be slightly lessened for from four to six hours after the administration of the drug. The percentage of excre-

2. Lundy, J. S.: Barbiturates as Anesthetics, Hypnotics and Antispasmodics; Their Use in 1,000 Surgical and Nonsurgical Cases in Man and in Operations on Animals, Cur. Res. Anes. and Anal., 8:360-365 (Nov.-Dec.) 1929.

3. Isenberger, R. M.: Investigation of Untoward Reaction in Relation to Local and Spinal Anesthesia, Proc. Staff Meetings, Mayo Clinic, 3:294-297 (Oct. 10) 1928.

4. Tatum, A. L.; Atkinson, A. J. and Collins, K. H.: Acute Cocaine Poisoning, Its Prophylaxis and Treatment in Laboratory Animals, J. Pharm. and Exper. Therap., 26:325-335 (Dec.) 1925.

5. Knoefel, P. K.; Herwick, R. P., and Loevenhart, A. S.: Prevention of Acute Intoxication from Certain Local Anesthetics, J. Pharm. and Exper. Therap., 39:397-411 (Aug.) 1930.

6. Deuel, H. J., Jr.; Chambers, W. H., and Milhorat, A. T.: Animal Colorimetry; Influence of Amytal upon Metabolism of Dog, J. Biol. Chem., 69:249-266 (July) 1926.

tion is usually increased or only slightly lessened. Within from eighteen to twenty-four hours, the absolute output is approximately normal. Phosphoric acid excretion is generally increased, both in minute rate and percentage output. The results show there is no evidence of severe kidney damage or depression, since the urea output remains fairly constant. The effect of amytal on blood sugar is still a mooted question. Loevenhart[5] found that amytal was more than five times as effective as barbital in protecting rabbits against death from procain. When considered from a molecular basis, the differences are even more significant. For example, a molecule of iso-amyl-ethyl-barbituric acid is five times as effective as a molecule of diethyl-barbituric acid.

This would naturally mean that the toxic dose would have to be much larger in proportion, because it proves that sodium amytal is burned up in the body, but, with barbital, the accumulative effect would materially reduce the amount required for a toxic dose. This toxicity would play an important part in the storage of body fluids, because the barbital would naturally be stored in some amounts; whereas, with amytal, one can readily see the difference.

A large number of patients at our state insane asylum have received daily injections of sodium amytal for months, and yet the physicians say that they are greatly improved. A patient suffering from paralysis agitans who came under my observation had taken 6 grains by mouth each day over a three year period without showing any evidence of a cumulative effect. In a case of cerebal thrombosis, the patient had been getting four 3-grain capsuls a day at six-hour intervals over a two-year period without showing any ill effect of the drug, while three patients who had taken one of the other barbiturates over a one and two month period were in the hospital being treated for barbituric acid poisoning, one case terminating fatally. All of which proves conclusively that amytal is not accumulative as are other similar preparations, and does not in any way affect the glomerular activity or these patients would have accumulated a toxic dose long before now.

When sodium amytal in small amounts is given for preanesthetic preparation of patients the respiration is regular, slower but deeper, the patient getting the same amount of air. The pulse rate varies, but there is usually a slight increase. There is little change in the color of the skin, although it may be flushed.

Isenberger,[7] in experiments on animals, showed the effect on respiration of sodium amytal alone and in combination with morphin. Respiration was decreased but deeper with small doses of sodium amytal, with no change in the minute volume. By repeating the dose in the same animal, a slight but definite fall in the minute volume of respiration was produced, owing to decline in the respiratory rate as the animal passed into a deep quiet sleep. Small doses of morphin given preliminary to sodium amytal produced a more intense action, and when they were used in combination with ether, surgical anesthesia was easily established. The decline in respiratory rate which follows the use of morphin in combination with sodium amytal seems to be brought on more rapidly. When morphin and sodium amytal were used and the animal completely anesthetized, each succeeding dose of morphin brought a reduction in minute volume of air breathed, but when additional doses of

7. Isenberger, R. M.: Am. J. Surg., 9:35-54 (July) 1930.

sodium amytal were used, there was no change in the minute volume of air. From these experiments, the conclusion could be drawn that morphin or repeated doses of morphin may cause shallow breathing which may be attributed to sodium amytal.

CIRCULATORY SYSTEM

The effects of sodium amytal on the circulatory system are dependent on the rate, amount and manner of administration of the drug. When it is given orally, the fall in blood pressure is not so great as when it is used intravenously. There is a decrease in both systolic and diastolic pressure during induction of anesthesia, with a gradual return to normal. Zerfas[8] states that the response of the pulse rate, which may be variable though seldom slowed, is probably due to the effect on the vagus nerve. There is no evidence of hemolysis or of agglutination of red cells in the circulation.

Blood sugar may be slightly increased, and there is no change in the bilirubin content of the blood serum. The absence of amytal from the urine after oral or intravenous administration of sodium amytal would lead one to believe that it is completely destroyed in the body. No study has been made as to the rate of disappearance in the blood stream or the content of amytal in body tissues or in the feces.

ADMINISTRATION AND DOSAGE

Sodium amytal may be administered rectally, intravenously, intramuscularly or orally. If the drug is given in large enough doses orally to produce unconsciousness, one is never certain that the continued absorption of the drug may not occur for some length of time. In office practice, one 3-grain capsul, given one hour before operation, has only a mild sedative effect and prepares the highly nervous patient so that either nitrous oxid or procain can be administered much more successfully.

If the patient is hospitalized, one 1½-grain or one 3-grain capsul the night before operation, and one or two 3-grain capsuls the following morning, two hours before operation, allow the patient to be brought to the operating room in a tranquil state of mind, without fear or apprehension, which is generally present without some form of premedication. According to McCallum and Zerfas,[9] there is only a very approximate relationship between body weight and dosage. The physical condition of the patient, age, nervous temperament and metabolic rate are more important factors in grading the dosage than body weight.

Patients of a nervous temperament require larger doses, and those suffering from chronic infection in which the body resistance has been lowered require smaller doses. Dosage for children varies somewhat according to the condition for which the drug is indicated. For preoperative preparation, from 1½ to 3 grains of sodium amytal for those under 10 years of age, and from 1½ to 6 grains for those over 10 years of age is advised.

It must be remembered that dosage depends especially on the general condition of the patient, the tonus of the nervous system and the age. The manufacturers of sodium amytal emphasize that, in the human being, it should not be used as an anesthetic since the small doses recommended exert effects essentially classified as hypnotic. The intravenous method of giving sodium amytal

8. Zerfas, L. G.: Sodium Amytal and Other Derivatives of Barbituric Acid, Brit. M. J., 2:897-902 (Nov. 29) 1930.

9. Zerfas, L. G., and McCallum, J. T. C.: Cur. Res. Anes. and Anal., 8:349-359 (Nov.-Dec.) 1929.

has been used in more than 1,000 major and minor surgical operations at Bethesda Hospital without a fatality which could be attributed to the drug. More than 200,000 cases have been reported in the United States. While the intravenous method has the advantage of rapid onset and intensity of action, the risks are characteristic of any therapeutic agent used intravenously.

The employment of a barbiturate as the sole anesthetic used should be limited to those cases in which other anesthetics are contraindicated. I have used as high as 24 grains intravenously in malignancies of the mouth where an electric cautery was indicated in the operative procedure. Several of these cases were poor operative risks for any anesthetic, as advanced cases of malignancy of the mouth are usually toxic.

Except when sodium amytal is given in a large dose intravenously, the skin reflex is present. When complete loss of consciousness is desired, from 4½ to 7½ grains is generally sufficient. One grain to 1 c.c. is injected directly into the vein, and the manufacturers emphasize that under no circumstances should 1 c.c. a minute be exceeded. Proper control of the rate of injection is possible, but the sensitive relationship between toxicity and the rate of injection is a danger encountered only in this method. The drug should be given by someone who is not only competent, but who has had experience in this type of work. When it was first used in Cincinnati, several patients became cyanotic with rapid fall in blood pressure, but when the solution was injected more slowly, the results were ideal. Blood pressure usually drops during the administration, but gradually returns to normal. This, of course, is an advantage in high blood pressure, as a slight increase may be dangerous. Patients who have received 15½ grains usually sleep from three to six hours, and occasionally longer.

The position of the patient must be changed from time to time owing to the possibility of pulmonary edema from long periods of unconsciousness.

If vascular depression should occur, ¾ grain of ephedrin sulphate and 7½ grains of caffein-sodium-benzoate should be administered hypodermically. Inhalations of oxygen or carbon dioxid are likewise indicated.

The administration of sodium amytal preliminary to administration of nitrous oxid-oxygen and the procain group has many advantages. Even in small doses given orally, it produces a slight stupor, yet the reflexes will be present. There is no respiratory depression and no long postoperative stupor. A patient who usually requires 93 per cent nitrous oxid and 7 per cent oxygen for maintenance will be sufficiently anesthetized with 80 per cent nitrous oxid and 20 per cent oxygen for any surgical operation about the mouth, provided relaxation is not required. When it is given orally in small doses, no fall in blood pressure has been noted, nor a change in respiration. In cases of generalized arteriosclerosis and hypertension in which sodium amytal was administered orally preliminary to nitrous oxid-oxygen, no change of any kind was noted.

Gatch and his associates at the Indiana University Hospital used a dosage by mouth which produced stupor and tended to abolish consciousness, yet left the patient reactive to painful stimuli.

They considered this the ideal state for the induction of inhalation anesthesia, and made no effort to establish oral dosage on the basis of body weight, but used amounts of the drug which they considered safe beyond question. Their

patients came to the operating room in a doze and had slight or no recollection of anything that happened. The breathing was free and unobstructed and no spasm of the respiratory muscles was noticed during the induction or maintenance of anesthesia. No drop in blood pressure and no respiratory failure was recorded.

The ease of induction and the absence of nausea and postanesthetic vomiting are pleasing both to the patient and to the operator. Where there are no contraindications, atropin one one-hundred or one one-hundred fiftieth grain, will check the action of the secreting gland, which, of course, is an advantage under local or general anesthesia, especially for oral surgery.

CONTRAINDICATIONS

Patients who are considered poor risks for anesthesia are poor risks for preliminary medication with sodium amytal; those suffering from hypertension and arteriosclerosis should be given sodium amytal with caution, and those having lung abscesses, pulmonary infections or bronchiectasis should be given only small amounts to avoid gagging.

SUMMARY

The use of barbiturates as a sole anesthetic is inadvisable except in malignancy of the head and neck, when the use of an electric cautery is a necessity.

Sodium amytal used orally or intravenously, preliminary to local anesthesia, is effective in allaying apprehension in the neurotic and hypersensitive patient.

No toxic manifestations of procain have been observed when sodium amytal is used preliminary to local anesthesia. Few patients have postoperative nausea when sodium amytal is used preliminary to nitrous oxid-oxygen anesthesia.

Patients given small doses of sodium amytal preliminary to nitrous oxid-oxygen anesthesia can be given a higher percentage of oxygen, and anesthesia can be induced and maintained without cyanosis.

Sodium amytal should not be considered an anesthetic, but a hypnotic used in the preparation of patients for local or general anesthesia.

DISCUSSION

Arthur E. Smith, Los Angeles, Calif.: One needs only to study what has been written on this subject during the past three years to be convinced that the safety of anesthetics has been tremendously enhanced by scientific preanesthetic medication. Every surgeon should be familiar with rational preanesthetic medication. Since the discovery of local and general anesthetics, there have been innumerable discussions on comparative anesthetic toxicity, with little or no regard for preanesthetic medication. Dr. Crile was among the first to point out the value of preanesthetic medication in his classic work on anoci-association. His teachings were criticized and ridiculed by many, only to be adopted later. Full credit should be given experimental laboratories for research showing that the barbiturates are chemical antidotes to procain and cocain poisoning. Many surgeons in both the medical and the dental profession are not taking cognizance of this fact. It has become a procedure with many other surgeons to give sodium amytal preceding a spinal anesthetic, one reason for this being its antidotal properties. Lundy, in a recent publication, has mentioned twelve different trade names for derivatives of barbituric acid, and states that sodium amytal, though not ideal, seems to fulfil more of the requisites than any of the other barbiturates. In gas anesthesia, it is quite generally recognized that the danger of death usually arises in the second stage of anesthesia. This period immediately follows the excitement stage. It is thought that, owing to psychic stimuli to the heart, ventricular fibrillation ensues, which is presumed to be the causative factor in this type of death. For this reason alone, one is justified in diminishing psychic stimulation by proper preanesthetic medication. This can be well illustrated in a severe case of hyperthyroidism in which efficient pre-

anesthetic medication is usually given. As Dr. Burmeister has pointed out, the purpose of preoperative medication is to minimize psychic shock and lower or prevent anesthetic toxicity, as well as regulate metabolic functions. The wide variance of susceptibility forbids the universal use of any one anesthetic or method of administration. Cannon has shown conclusively that fear and mental shock induce bodily changes to a greater or less degree, this depending on the duration and intensity of these various stimuli. Therefore, fear, apprehension and pain, which are paramount in every individual, are obstacles to be overcome and eliminated. By abolishing these conditions through adequate preliminary sedation, the stage of excitement which otherwise persists throughout the entire local, and induction and excitement stage of general, anesthesia, is conspicuous by its absence. The end-result is a much lower level of narcosis with its attendant stormy and delayed convalescence, as well as less postoperative nausea, vomiting, discomfort and pain. By a satisfactory preoperative environment, suggestive therapeutics, judicious selection of preanesthetic drugs and scientific administration of the general or local anesthetic, much psychic reaction is eliminated. In a paper read before the Illinois State Dental Society in 1914, I made the statement that there was no reason or excuse for a patient experiencing the slightest pain while undergoing surgical or dental procedures, if the operator was familiar with preanesthetic medication and the scientific administration of local or general anesthetics. As the years pass, I can reiterate that to inflict pain on a patient in this modern age is but a reflection on the operator. It is with much pride and enthusiasm that I can say that many of my patients undergoing plastic and oral surgery have the recollection only of preliminary medication and its environment. They emerge from the cycle of preanesthetic, anesthetic and operation unaware of what has taken place. For preanesthetic medication, the barbiturates, in adequate dosage, answer the purpose in dental extractions and in minor surgery. In major surgical procedures, it is usually necessary to use in addition opiates, atropin and scoplamin in order to obtain the necessary relaxation with a minimum of toxic anesthetic vapors. For several years, I have used, with gratifying results, both the iso-amy-ethyl barbituric acid and sodium iso-amy-ethyl barbituric acid in a large series of cases in nerve blocking and general anesthesia. They unquestionably have reduced procain toxicity. Efficient premedication often makes it possible for the surgeon to do his work expeditiously and well with either nitrous oxid or ethylene gas and oxygen alone. If ether is necessary, about one-fourth the amount usually required suffices. The patient alone is capable of realizing what this means during the period of recovery and subsequent convalescence. The following points should be stressed relative to the preliminary preparation of the patient for a general anesthetic, and as far as applicable for a local: Thorough alkanization of the patient should be assured by giving for two days preceding operation copious draughts of orange or grapefruit juice, to which glucose has been added to supply excess glycogen to the liver. Of equal importance, and now considered a part of the preliminary preparation, is a good night's rest previous to the day of operation, assured by administration of some efficient hypnotic, such as amytal, pentobarbital sodium or sodium amytal. Proper sedative hypnotics and opiates should be routinely administered at intervals of one or two hours before the time set for operation. The room should be darkened and no relative permitted to disturb the patient before operation. Induction of the anesthetic by nitrous oxid is quickly begun when the patient is brought to the operating room. If preanesthetic medication has not already produced unconsciousness, all due care should be used to avoid extraneous noises, such as laughing, talking or the arrangement of pans and instruments. Many patients have suffered needlessly because of this courtesy being unintentionally denied them. Attention to or disregard of these details, consideration of which every patient is entitled to, spells either the success or the failure of the anesthetic.

THE LIMITING EFFECT OF COAGULATION ON THE ACTION OF GERMICIDES*

By BERNICE TRACY HORTON, M.S., and PAUL C. KITCHIN, M.S., D.D.S.,
Columbus, Ohio

THE objective of this work has been either to confirm or refute the idea that an antiseptic is selflimiting in its action if it is a coagulant. Our attention has been centered largely on those agents which have been recommended for use in root-canal therapy. In addition, we have included 5 per cent chromic acid and 5 per cent potassium dichromate because of their importance in the treatment of Vincent's infection. Sodium dichromate has been suggested instead of potassium dichromate because it is less expensive.[1] It is our belief that they may be used interchangeably. Of the two that we used, the chromic acid is a strong coagulant and the potassium salt has practically no effect in this regard. Hydrochloric acid has also been included in order to determine whether the inhibition might be due to the change in the p_H of the medium produced by the activity of the hydrogen ion. This question arose especially in connection with chromic acid. We do not believe it to be a factor in the other germicides.

*From the research laboratory of the Ohio State University, College of Dentistry.

*Read before the Section on Histology, Physiology, Pathology, Bacteriology and Chemistry (Research) at the Seventy-Fourth Annual Session of the American Dental Association, Buffalo, N. Y., Sept. 14, 1932.

1. Kitchin, P. C., and Brown, J. B.: Preliminary Report on Mouthwash for Treatment of Vincent's Infection, D. Cosmos, 74: 538 (June) 1932.

METHOD

The plate-cup method of testing antiseptics was used.[2] Flasks of Liebig's meat extract-agar, which contains no coagulable proteins, were inoculated with the desired organism. To one half of the flasks, 10 per cent horse serum was added, furnishing a medium containing coagulable proteins. Plates were then poured, approximately 20 c.c. to each plate. When the plates had solidified, a cup was cut in the center with a sterile cork borer. The bottom of the cup was sealed with a small amount of melted agar. In this cup, we placed 0.5 c.c. of the reagent to be tested, and immediately placed a sterile glass cover-slip over the cup and gently pressed it into the agar. This was an attempt to completely seal the antiseptic in the cup and prevent it from reaching the surface except by diffusion through the agar. It also permitted the inversion of the plate for incubation.

The method is illustrated in Figure 1, in which the Petri dish labeled *1* shows the action of 5 per cent chromic acid on *Staphylococcus aureus* in the presence of serum. The dark area in the center is the cup in which the antiseptic was placed. The white area surrounding it is the coagulated serum. The clear space be-

2. Methods of Testing Antiseptics and Disinfectants, Bull. 198, U. S. Dept. of Agriculture.

yond indicates the extent of inhibition and the rest of the plate is covered with a prolific growth of the organism. The Petri dish labeled *1* represents the same conditions except that the serum has been omitted from the medium, and, hence, coagulation has been no factor in the inhibition of the bacterial growth.

Forty plates were made for each reagent. Ten plates of each medium were inoculated with *Staphylococcus aureus* and ten more of each medium with *Eberthella typhi.* The latter organism was chosen because it is a standard test bacterium. *Staphylococcus aureus* was used not only because it is a standard test, gram-positive, non-spore-forming organism, but it also represents one group of bacteria which commonly occur in infected root canals. Streptococcus strains, which are perhaps the most important bacteria in infected root canals, could not be used because no medium which is suitable for their growth is entirely free from coagulable proteins. Furthermore, streptococci were not desirable for our purposes because their growth is typically delicate and translucent.

After a forty-eight hour incubation period at 37 C., the zones of complete inhibition of the bacterial growth were measured at a number of places from the edge of the cup to a point where the growth was apparent. The average of these measurements are recorded in Tables 1-4. The average width of the coagulum was obtained in the same manner and is recorded in the same tables.

DISCUSSION OF RESULTS

The results of the work, with the exception of those following the use of formocresol, which extended beyond the limits of the graph, are shown in Figures 2-3. The first of these diagrams deals with the action of the other eleven reagents on *Staphylococcus aureus.* The left hand open column under each antiseptic shows the extent in millimeters of the inhibitory action in a noncoagulable medium. The solid black column represents the same in a coagulable medium. In every case, where coagulation was evident, it is indicated by a short line to the right of the column. The percentage of increase and decrease in the inhibitory power is shown by the dotted space in relation to these two columns. Figure 3 shows the same data in regard to *Eberthella typhi.*

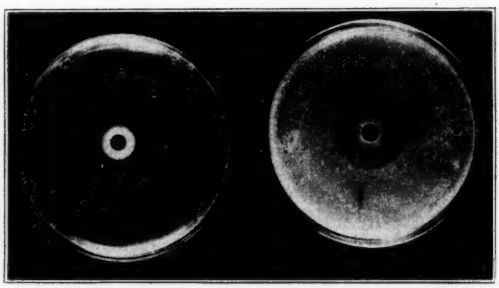

Fig. 1.—Effect of 5 per cent chromic acid on Staphylococcus aureus (*1,* extract-agar; *1',* serum-agar).

In every case, where coagulation occurred, there was a decrease in the antiseptic value of the reagent, with the notable exception of metacresyl acetate,

TABLE 1.—EFFECT OF COAGULATION ON THE ANTISEPTIC POWER OF BEECHWOOD CRESOTE, FORMO-CRESOL AND 5 PER CENT PHENOL

	Beechwood Creosote				Formo-Cresol				5 Per Cent Phenol			
	Staph. Aureus		E. Typhi		Staph. Aureus		E. Typhi		Staph. Aureus		E. Typhi	
	Extract-Agar	Serum-Agar	Extract-Agar	Serum-Agar	Extract-Agar	Serum-Agar	Extract-Agar	Serum-Agar	Extract-Agar	Serum-Agar	Extract-Agar	Serum-Agar
Corresponding number in photographic series	2	2′	2A	2A′	3	3′	3A	3A′	4	4′	4A	4A′
Range in antiseptic action expressed in millimeters (10 plates)*	8-10	7-10	17-23	17-22	0	0	0	0	1-3	0-2	4-7	3-7
Average extent of antiseptic action in millimeters (10 plates)	9	8.7	19.7	18.6	42.5	42.5	42.5	42.5	1.8	1.3	5.4	4.7
Average extent of coagulation in millimeters (10 plates)	0	5	0	5	0	2	0	4	0	Slight haze	0	Slight haze
Average decrease in efficiency on addition of serum	3.3% (0.3 mm.)		5.6% (1.1 mm.)		0%		0%		27.8% (0.5 mm.)		13% (0.7 mm.)	
Average increase in efficiency on addition of serum					0%		0%					
Remarks					A precipitate other than the coagulum was formed; the entire plate was inhibitory to growth				Agrees with results obtained in a class of 30 students			

*Indicated by the distance of complete inhibition of bacterial growth extending from the edge of the cup.

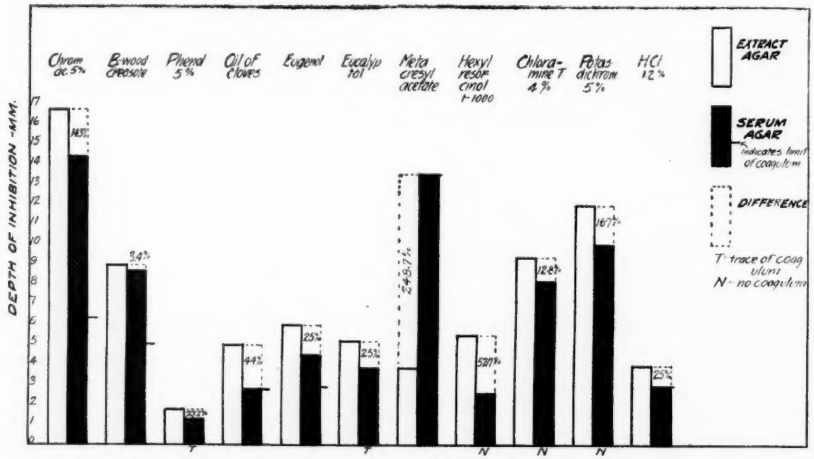

Fig. 2.—Effect of coagulation on inhibition of Staphylococcus aureus.

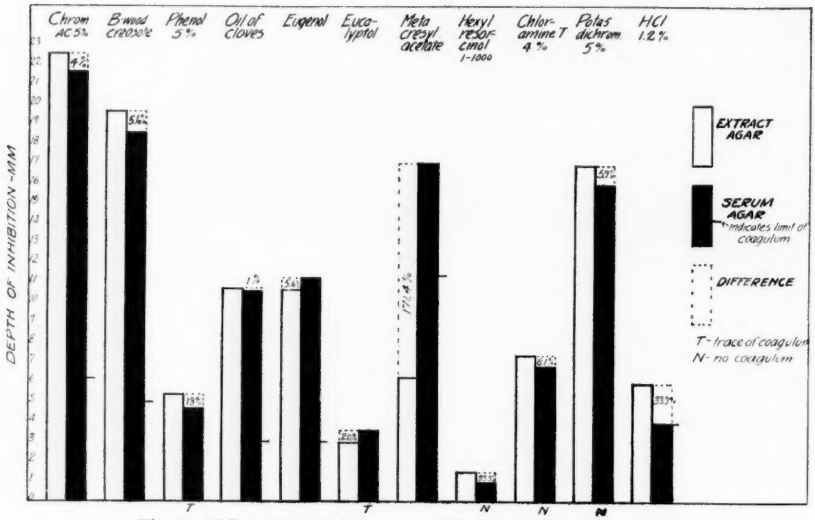

Fig. 3.—Effect of coagulation on inhibition of Eberthella typhi.

which showed a marked increase in its action. To a lesser extent, eugenol and eucalyptol showed an increase in their ability to inhibit the growth of *E. typhi.* Although there was an appreciable decrease, from 44 to 1 per cent, in the effectiveness of the antiseptics when coagulation occurred, this decrease is not entirely due to the coagulation of the serum. In those cases in which coagula-

tion did not occur, there is also a marked decrease, from 52.7 per cent to 5.9 per cent, in the extent of the inhibitory zone. This can be attributed only to the presence of the serum, which is the one variable.

A comparison of the action of chromic acid and potassium dichromate in Table 4 will illustrate this point very well. Here, we have presumably the same active principle, the chromate ion. But, in the one case, a compact and quite extensive coagulum is formed and, in the other instance, there is not the slightest indication of coagulation. In comparing the percentage of decrease in the efficiency of these two, we find that there is approximately 2 per cent more of a decrease in the action of potassium dichromate, the noncoagulant, than of chromic acid, the strong coagulant.

Figure 4 illustrates the action of potassium dichromate on *Staphylococcus aureus* in the extract medium (*11*) and in the serum medium (*11'*). The Petri dishes labeled *11A* and *11A'* show the effect of the same reagent on *E. typhi* in the extract and serum mediums, respectively. A contrast is seen in the effect of oil of cloves, a coagulant, on *E. typhi* in a noncoagulable medium (*5A*) and in a medium where a distinct area of coagulation is evident (*5A'*).

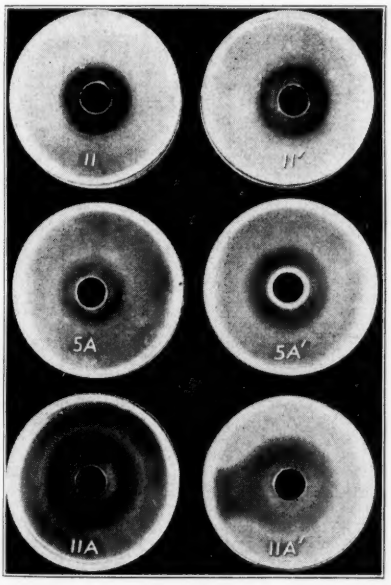

Fig. 4.—Effect of potassium dichromate on Staphylococcus (*11*, extract-agar; *11'* serum-agar) and E. typhi (*11A*, extract-agar; *11A'* serum-agar) and oil of cloves on E. typhi (*5A*, extract-agar; *5A'*, serum-agar).

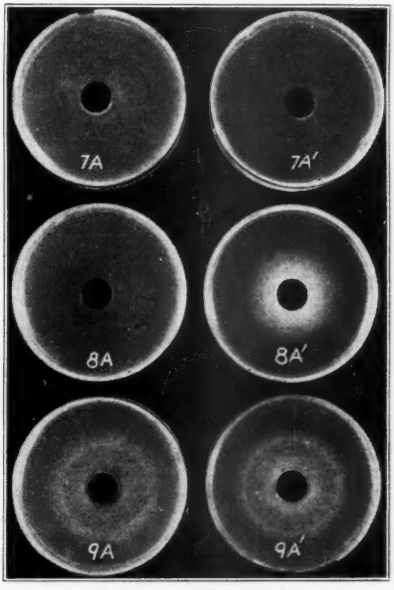

Fig. 5.—Effect of eucalyptol (*7A*, extract agar; *7A'*, serum-agar), metacresyl acetate (*8A*, extract agar; *8A'*, serum-agar) and hexylresorcinol (*9A*, extract agar; *9A'*, serum-agar) on E. typhi.

The question might be asked, "How much of this action is attributable to a change in the p_H of the medium due to

TABLE 2.—EFFECT OF COAGULATION ON THE ANTISEPTIC POWER OF OIL OF CLOVES, EUGENOL AND EUCALYPTOL

	Oil of Cloves				Eugenol				Eucalyptol			
	Staph. Aureus		E. Typhi		Staph. Aureus		E. Typhi		Staph. Aureus		E. Typhi	
	Extract-Agar	Serum-Agar	Extract-Agar	Serum-Agar	Extract-Agar	Serum-Agar	Extract-Agar	Serum-Agar	Extract-Agar	Serum-Agar	Extract-Agar	Serum-Agar
Corresponding number in photographic series	5	5′	5A	5A′	6	6′	6A	6A′	7	7′	7A	7A′
Range in antiseptic action expressed in millimeters (10 plates)*	4-6	1-4	10-12	10-12	0	4-6	9-13	10-13	4-8	2-6	2-5	2-5
Average extent of antiseptic action in millimeters (10 plates)	5	2.8	10.7	10.6	6	4.5	10.7	11.3	5.2	3.9	3	3.6
Average extent of coagulation in millimeters (10 plates)	0	3	0	3	0	3	0	3	0	Slight	0	Slight
Average decrease in efficiency on addition of serum	44% (2.2 mm.)		1% (0.1 mm.)		25% (1.5 mm.)				25% (1.3 mm.)			
Average increase in efficiency on addition of serum							5.6% (0.6 mm.)				20% (0.6 mm.)	
Remarks	Area of inhibition colored yellow				Area of inhibition clouded with a slight precipitate other than coagulated serum							

*Indicated by the distance of complete inhibition of bacterial growth extending from the edge of the cup.

TABLE 3.—EFFECT OF COAGULATION ON THE ANTISEPTIC POWER OF CRESYL ACETATE (META), HEXYLRESORCINOL AND 4 PER CENT CHLORAMIN-T

	Cresyl Acetate (Meta)				Hexylresorcinol				4% Chloramin-T			
	Staph. Aureus		E. Typhi		Staph. Aureus		E. Typhi		Staph. Aureus		E. Typhi	
	Extract-Agar	Serum-Agar	Extract-Agar	Serum-Agar	Extract-Agar	Serum-Agar	Extract-Agar	Serum-Agar	Extract-Agar	Serum-Agar	Extract-Agar	Serum-Agar
Corresponding number in photographic series	8	8′	8A	8A′	9	9′	9A	9A′	10	10′	10A	10A′
Range in antiseptic action expressed in millimeters (10 plates)*	3-4	12-16	5-8	13-19	4-6	2-4	1-2	0-1.5	9-11	7-10	6-10	5-9
Average extent of antiseptic action in millimeters (10 plates)	3.9	13.6	6.3	17.1	5.5	2.6	1.5	1	9.4	8.2	7.4	6.8
Average extent of coagulation in millimeters (10 plates)	0	13.6	0	11.5	0	0	0	0	0	0	0	0
Average decrease in efficiency on addition of serum					52.7% (2.9 mm.)		33.3% (0.5 mm.)		12.8% (1.2 mm.)		8.1% (0.6 mm.)	
Average increase in efficiency on addition of serum	248.7% (9.7 mm.)		171.4% (10.8 mm.)									
Remarks					A band of partial inhibition extended beyond the zone of complete inhibition in each plate.							

*Indicated by the distance of complete inhibition of bacterial growth extending from the edge of the cup.

TABLE 4.—EFFECT OF COAGULATION ON THE ANTISEPTIC POWER OF 5 PER CENT CHROMIC ACID, 5 PER CENT POTASSIUM DICHROMATE AND 1.2 PER CENT HYDROCHLORIC ACID

	5% Chromic Acid				5% Potassium Dichromate				1.2% Hydrochloric Acid			
	Staph. Aureus		E. Typhi		Staph. Aureus		E. Typhi		Staph. Aureus		E. Typhi	
	Extract-Agar	Serum-Agar	Extract-Agar	Serum-Agar	Extract-Agar	Serum-Agar	Extract-Agar	Serum-Agar	Extract-Agar	Serum-Agar	Extract-Agar	Serum-Agar
Corresponding number in photographic series	1	1′	1A	1A′	11	11′	11A	11A′	12	12′	12A	12A′
Range in antiseptic action expressed in millimeters (10 plates)*	15-19	12-17	21-24	19-23	†							
Average extent of antiseptic action in millimeters (10 plates)	16.8	14.4	22.6	21.7	12	10	17	16	4	3	6	4
Average extent of coagulation in millimeters (10 plates)	Trace	6.3	Trace	6.2	0	0	0	0	0	3	0	4
Average decrease in efficiency on addition of serum	14.3% (2.4 mm.)		4% (0.9 mm.)		16.7% (2 mm.)		5.9% (1 mm.)		25% (1 mm.)		33.3% (2 mm.)	
Average increase in efficiency on addition of serum												
Remarks	Entire plate colored yellow				Yellow discoloration extended beyond zone of antiseptic action				Inhibition did not extend beyond zone of coagulation			

*Indicated by the distance of complete inhibition of bacterial growth extending from the edge of the cup.
†The range was small in the plates of 5 per cent potassium dichromate and 1.2 per cent hydrochloric acid, but no accurate record was kept.

the activity of the hydrogen ion in the chromic acid?" In Table 4, we see that the 1.2 per cent hydrochloric acid, which has approximately the same hydrogen ion concentration as the 5 per cent chromic acid, inhibits the growth of *Staphylococcus aureus* for a distance of 4 mm. from the edge of the cup. When this is compared with the 16.8 mm. activity of chromic acid, it seems almost insignificant. Furthermore, the mediums used are buffered to such degree that the p_H would hardly be changed by the amount of the reagent used. This is indicated by the data in Table 5, which shows that nineteen times as much acid was required to change the mediums to p_H 3 as was needed to change a suspension of agar in

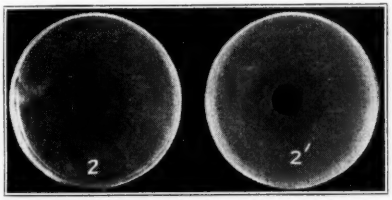

Fig. 6.—Effect of beechwood creosote on Staphylococcus aureus (*2*, extract agar; *2'*, serum-agar).

water to the same p_H. The quantities used in securing these data were in a proportion of 1:4. When compared to the 1:40 ratio between the antiseptic and the medium used in the plate-cup method, it seems that the possibility of any change in the p_H of the medium accounting for the inhibition of the bacterial growth is very slight. The addition of the serum to the medium did not seem to increase the buffer action to any appreciable degree.

The greatest decrease in antiseptic action, 52.7 per cent, was shown when hexylresorcinol was used against *Staphylococcus aureus* (Table 3), and it occurred without the formation of a coagulum.

In Plate 5, the Petri dishes labeled *9A* and *9A'* show the action of 1:1,000 hexylresorcinol on *E. typhi* in the absence and presence of serum respectively. The inhibition of this reagent is divided into a zone of complete and one of partial action. This is the only antiseptic used that exhibited this effect. Here also the decrease in antiseptic action was unaccompanied by serum coagulation. The decrease in the diffusion in the presence of serum without coagulation may be explained, to some extent at least, by the fact that the serum increases the microscopic viscosity of the medium. This can be demonstrated by the slightly slower penetration of aqueous gentian violet into the serum medium, as compared with its penetration into the plain extract medium.

Considering the action on both *Staphylococcus aureus* and *E. typhi,* beechwood creosote was, with the exception of formocresol, affected the least by the presence of serum. The formocresol showed no decrease in its action on the addition of serum to the medium. We cannot be sure that our seal was perfect and the volatile formalin (solution of formaldehyd) may have been responsible for the inhibition of the bacterial growth which occurred over the entire plate. Formalin does not coagulate serum; hence, there was no indication that there was, or was not, an escape of vaporized formalin. Had we used a greater area than the Petri dish afforded, we might have found the limits of its penetration. In that event, there might have been some difference induced by the presence of the serum.

The decrease in the antiseptic power of beechwood creosote in the presence of serum was 5.6 per cent when used

against *Staphylococcus aureus.* This is shown in Plate 6, *2* being in the extract medium and *2'* in the serum medium. While the coagulation is not so plain here as in other illustrations shown (chromic acid, oil of cloves and metacresyl acetate), it is still quite evident. When used with *E. typhi,* the decrease is only 3.4 per cent. This decrease is slight when compared with that of other reagents which are so affected. The limiting effect on the penetration of beechwood creosote by the coagulated serum is hibited by beechwood creosote. It seems very consistent in its ability to inhibit the growth of both of the organisms when used under the varying conditions. We feel that the results obtained, particularly in regard to beechwood creosote, indicate that the idea of its limitations caused by its coagulating powers has been overemphasized.

When we consider the greatly increased activity of metacresyl acetate and, to a slighter degree, that of eugenol and eucalyptol in the presence of coagulation,

TABLE 5.—BUFFER ACTION OF EXTRACT AND SERUM AGAR

	Agar and water and 15 drops of bromphenol blue	Extract agar and 15 drops of bromphenol blue	Serum agar and 15 drops of bromphenol blue
Amount of tenth normal hydrochloric acid required to change the p_H of the medium to a $p_H 3$	0.5 c.c.	9.5 c.c	9.5 c.c.*
Extent of penetration of the hydrogen ion, indicated by the color change when 1.2 per cent hydrochloric acid was added	5.75 cm.	3.5 cm.	3.0 cm.
Extent of color change when when 5 per cent chromic acid was added	0.5 cm. color of the chromate ion was evident for 1.5 cm.	2.5 cm. color of the chromate ion was evident for 2 cm.	3.0 cm. color of the chromate ion was evident for 2.8 cm.

*The serum contained hemoglobin and made the color observation difficult.

probably of little or no practical importance. The zone of inhibition extended far beyond that of coagulation, especially in the plates of *E. typhi,* where the average distance of coagulation is less than one third that of complete inhibition.

We are impressed, as in our previous work,[3] with the uniformity of action exwe are unable at the present time to offer any reasonable explanation. Therefore, we merely report it as occurring regularly in a series of twenty serum plates and as an example of certain conditions in which the presence of coagulable proteins is an aid rather than a hinderance to the penetration of an antiseptic.

3. Kitchin, P. C., and Horton, Bernice T.: Relative Efficiency from Bacteriologic Standpoint of Some Materials Used in Treatment of Putrescent Root Canals, J.A.D.A., 18: 1668 (Sept.) 1931.

SUMMARY OF RESULTS

1. In some cases, the presence of coagulable proteins may markedly increase

the action of an antiseptic, as in the case of metacresyl acetate.

2. Chromic acid is more effective against the test organisms than potassium dichromate and is affected less by the addition of serum, although it is a strong coagulant; while potassium dichromate is a noncoagulant.

3. The antiseptic power of hexylresorcinol, a noncoagulant, is impaired greatly by the presence of serum.

4. Beechwood creosote, although a coagulant, is limited very little in its action against the test organisms by the presence of coagulated serum.

5. The fact that an antiseptic is a coagulating agent does not always indicate that it is self-limiting in its action.

MAXILLARY SINUSITIS DUE TO TOOTH INFECTION*

By FRANK H. WANAMAKER, M.D., D.D.S., Seattle, Wash.

WHEN considering the relationship between the teeth and the maxillary sinuses, it is natural that we should think of the relationship between the practitioners who are especially concerned with affections of these anatomic parts, that is, the oral surgeon and the rhinologist. If either one is to do his work satisfactorily, he must have an adequate working knowledge of the specialty of the other.

Of all the nasal accessory sinuses, the maxillary sinus or the antrum of Highmore is the one in which the dental surgeon is primarily interested. This sinus is located in the maxilla and follows in the main the shape of the body of the bone or presents the shape of a three-cornered pyramid. It may be considered as having three walls, a roof and a floor. While there is considerable variation in size, average measurements may be given as follows: anteroposterior, 34 mm.; vertical, 38 mm.; mediolateral, 23 mm.

The actual shape of the antrum, as well as its location in relation to the jaw, varies to a certain extent even in normal persons. Except for the lower internal portion, which is the outer wall of the inferior meatus of the nose, the antral walls are very thick. In most adults, the floor of the antrum will be found on a level with the floor of the nose, but, in some persons, it will be found lying considerably lower. Thus, the lower part of the cavity assumes the shape of a pocket ready to act as a catch basin for those secretions that may be dammed back by some abnormal nasal condition. It is, of course, this antral floor which comes in contact with the teeth and so close is this relationship that very often the roots of the teeth penetrate it. It is very seldom that we find a case of maxillary sinusitis caused by teeth if the dental line is unbroken. If the teeth are examined and a careful history is obtained, it will be found, in the majority of cases, that a molar tooth has been extracted recently or that a pulpless tooth is present. One must not be content in examining only the molars,

*Read before the Medicodental Section at the Third Triennial Session of the Pacific Coast Dental Congress, Seattle, Wash., July 7, 1932.

as any tooth from the incisors backward may be the primary focus of infection.

The normal opening of the antrum is high up in the nose, in the area of the middle turbinate bone and, in order that the secretions may be evacuated, Nature has lined the cavity with a highly specialized membrane made up of many ciliated cuboidal cells. The cilia have a wavelike motion toward the opening and any pus is gradually lifted or rolled up through the normal aperture. The position of the head also aids drainage, especially with the head down and the nasolateral wall most dependent.

One may compare the living membrane of the antrum to a room lined with velvet, with its many millions of threads protruding into the room. Since the antral opening is so small, it can be appreciated how quickly this entrance may be occluded when any inflammation of the mucosa occurs, and drainage completely cut off. The sinuses normally are sterile cavities, but the most common bacteria that are found in infections of the mucosa are *Streptococcus viridans, Staphylococcus aureus,* the pneumococcus and *Bacillus pyocyaneus.* On culturing and making smears of the foul-smelling, thin, peasoup-like pus that is obtained, the above mentioned types of bacteria are all that have been found.

I am unable to tell what gives the peculiar odor to pus that is due to an infected tooth unless it is the marked ulceration of the living membrane. At times, with production of a gas that smells like rotten eggs, an inflammatory reaction within the sinus itself may be so great as to result in a thickening of the mucous membrane to the extent that polypoid formation may take place with ulceration.

The diagnosis naturally presents many difficulties and requires a careful examination of the case. The routine followed in attempting to make a diagnosis reveals the following:

1. The clinical history leads toward a suspicion of maxillary sinus involvement when there is (a) a foul smelling discharge from the nose, (b) a bad taste, (c) headache, especially confined to the same side of the head as the infection or (d) pain and dizziness on stooping or jarring.
2. Pressure over the antrum will often elicit pain.
3. Within the nose, there is congestion of the soft tissues and pus is found, most commonly in the middle meatus.
4. By transillumination of the antrums, one finds the affected sinus to be dark.
5. On irrigation, by means of a trocar through the inferior meatus, a very foul-smelling green pus will be obtained.
6. The roentgen rays show the affected sinus to be cloudy. Lipiodal injected through the trocar after irrigations will very often show a thickened or a polypoid membrane.

One may have difficulty in determining which tooth is causing the antrum infection. This, of course, is determined by the patient's stating that a certain tooth hurts, has a sore feeling or is tender when biting. On examination, it is found that the tooth is discolored, crowned or has a large filling. At times, the foregoing will not be present and only one pulp in the tooth will be dead, but, on testing the tooth, it will be found to be hypersensitive.

When the diagnosis has been established, either by the customary methods of transillumination and examination of the washings or some of the more extraordinary measures necessity may force

on us, the question of treatment becomes of importance. It is my opinion that, in a large proportion of antral infections, the teeth have been the exciting cause, but that the extraction of the offending tooth should not be regarded as a measure for producing an opening through the aveolar process for drainage and treatment. When the source of the infection has been removed, it is in general better by far to handle the case intranasally.

One should irrigate the sinus daily or every other day through a trocar placed through the inferior meatus, or through the normal opening, using a warm soda or saline solution interspersed with one or more washings of dilute hydrogen peroxid. If, after ten or twelve washings, we find no mucoid change or decrease in the pus, a radical operation is indicated. One may choose the Caldwell-Luc or Denker or an intranasal operation. My operation of choice is the Caldwell-Luc which consists of an incision in the labial fold or parallel to it over the canine fossa.

Shearer,[1] of Omaha, makes a low incision in order to avoid cutting a branch of the infra-orbital nerve, which results in a numb feeling in the lip. The periosteum is retracted and a circular opening one-half inch in diameter is made in the bone. This gives a good view of the interior of the antral cavity. The lining membrane is then dissected free with a small dental scaler or a small dissector. After the lining membrane has been removed, a window is made through the bone, leading into the inferior meatus, and thus giving aeration and drainage to the antral cavity. A flap from the mucous membrane of the inferior meatus may be turned down into the antral floor. This keeps the window from closing too soon. One-half inch vaselined gauze is then inserted through the window into the antrum and allowed to remain for two or three days to control any hemorrhage. Washing of the antrum through the window every day until the blood clots are completely removed facilitates healing.

Very often, we are confronted with a fistulous tract running from the mouth into one of the maxillary sinuses. If the fistula is lined with epithelium and has considerable scar tissue around it, one will meet with great difficulty in effecting a closure.

Alveolar fistulas into the antrum are the result of four different conditions, according to Lyons[2]:

1. The presence of dental roots within the antrum, which cause a fistula when extracted. Such a fistula, with the resulting antrum infection, is comparatively rare and, of course, unavoidable. 2. The presence of roots extending to, but not through, the floor of the antrum, where, after extraction, the probes or curets used penetrate the antrum accidentally and result in a fistula. 3. The breaking down of the floor of the antrum, by dental apical abscesses or granulomas, resulting in fistula after extraction of the tooth. 4. An accident occurring during extraction, when the root is forced into the antrum but the dental root does not involve the floor of the antrum.

When a fistula has been present a month or longer, it becomes lined with epithelium, making a permanent opening and one that curettement will not eliminate. In the treatment of a chronic fis-

1. Shearer, W. L.: Pathology of Alveolus —Relation to Maxillary Sinus—Method of Approach, Tr. Am. Soc. Laryn., Rhin. & Otol., 1927, p. 558.

2. Lyons, H. R.: Treatment of Alveolar Fistula Secondary to Extraction of Teeth, Tr. Am. Soc. Laryn., Rhin. & Otol., 1925, p. 81.

tula, it is first necessary to relieve the chronic infection of the antrum, and, secondly, to eliminate the fistula. When one is positive that the antrum is no longer infected, the fistula may be closed. It is advisable first to destroy the epithelial lining with the electric cautery. The more marked the reaction following the burning, the quicker the closure. Trichloracetic acid may also be used. Many times, we will not effect a closure and plastic surgery will have to be resorted to.

Welty,[3] under general anesthesia, makes an incision at each end of the fistula on the outer side of the alveolar process and carries it well up to where the bone has been removed in the antrum operation. Periosteum and mucous membrane are removed from the alveolar process and later the whole of the outer border of the alveolar process is moved into the fistulous opening. A similar incision is made on the inside at each end of the fistula; the periosteum and mucous membrane elevated from the bone, and the bone removed. An incision is now made in the median line of the hard palate throughout its entire length and the periosteum elevated over the entire area. This removes all the tension from the sutures, and to prevent them from cutting through, a lead plate or rubber tubing may be used. This can remain for ten days. Plastic surgery has failed to close many of these fistulous openings, for several reasons: failure to cure the antrum infection before attempting to close the fistula; postoperative infection; cutting through of the sutures, and failure to remove the epithelized lining of the fistula.

3. Welty, C. F.: Closure of Fistulous Openings Through the Alveolar Process into Antrum of Highmore, J. A. M. A., 75:867 (Sept. 25) 1920.

CONCLUSION

By closure of the alveolar opening, we cut off a fertile source of infection from below; and by performing a proper intranasal operation, we obtain, maintaining it permanently if necessary, as is needed in chronic cases, an opening into the antrum whereby we are assured of ease of medication and free aeration and drainage; which, to my mind, is of the utmost importance in all infections of this sinus and which it is impossible to obtain if intervention is undertaken through the oral cavity.

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DIAGNOSIS OF DISEASES OF THE GINGIVAE*

By FREDERICK W. MERRIFIELD, D.D.S., M.D., Chicago, Ill.

THE topic I have chosen for discussion is that phase of oral diagnosis which concerns diseases of the gums, and I will try to set down and compare the manifestations of the common ones and also to call attention to some of those more rare, yet seen with enough frequency to warrant consideration at all times, when a diagnosis is to be made.

Perhaps the most important thing in making a diagnosis of these conditions is the examination. A history may or may not be so important. Laboratory examination may be of extreme importance, while roentgenographic examination may be of only confirmatory aid.

Mouth examinations should be painstaking and thorough and a matter of routine. A casual glance at the gums is never sufficient to warrant an expression of opinion as to the health of these tissues.

The pinkest, healthiest looking gums encircling perfectly formed clean teeth, free from decay, may be seriously involved in lesions of the peridental membrane and alveolar bone, and the most neglected, uncared for and dirty looking teeth may be associated with a severe gingivitis readily cured by a simple, thorough prophylactic treatment. Early recognition and treatment of inflammation of the gingivae result in prevention of disease in the deeper structures.

A systematic plan of examination and recording of all conditions found should be adopted. The record is as important as the examination because one starts with a composite picture of the presenting conditions and from future reference may gain an accurate idea of the success or failure of the particular treatment instituted. A routine examination will be by far the most satisfactory procedure regardless of whether the patients come in at more or less definite intervals, complaining of some particular pain or discomfort or as a result of a secondary infection in connection with which some mouth focus is sought.

A general inspection of the mouth is to be followed by a critical inspection of the mucous membranes, teeth and investing tissues, first in the one jaw and then the other, upper and lower.

In the general survey, the condition of the teeth may be noted, as to atrophy or hypoplasia, erosion or abrasion and the extent of dental operations. The entire mucous membrane is to be inspected and abnormal conditions noted. General cleanliness or lack of it is to be estimated and salivary deposits are to be recorded. During this survey, one will have gained a fairly accurate idea of the patient's temperament and physical and nervous make-up.

*Read before the Section on Periodontia at the Seventy-Fourth Annual Session of the American Dental Association, Buffalo, N. Y., Sept. 13, 1932.

The critical examination now follows, and any definite satisfactory plan of procedure may be adopted if the existing conditions are accurately recorded. This is somewhat a matter for the individual. I would recommend to anyone interested a study of the chapter on mouth examinations in Black's "Special Dental Pathology." The examination chart is unique and provides for a definitely accurate record of the conditions found relating to each particular tooth surface, and concerning either the hard or soft tissues, or the abnormal relation of tooth to tooth.

Our investigation begins with the mucous membranes, which may disclose points of swelling, abnormal redness, abnormal thickening and pallor, such as is seen in leukoplakia, and submucous thrush infection, sinus openings, etc. The investing tissues of the teeth are next examined, beginning at the crests of the gingivae. Recession and inflammatory areas should be noted as well as deposits of calculus. At this time, the quality of fillings, crowns, etc., may be estimated. Habits peculiar to the individual which cause injury to teeth or gums may be recognized as being incidental to the mode of cleansing and caring for the mouth employed by the patient. Detachments of the peridental membrane from the cementum should be sought and deposits of serumal calculus located. Digital examination will often disclose bone absorption or bony enlargements, also the presence of pus either around the teeth or in cavities from which sinuses open on to the soft tissue surfaces. These sinuses should be explored and the quality of bone determined by means of a sharp steel probe. All teeth should be tested for vitality, especially for the response to heat, and roentgengrams should be made of the entire mouth as a routine procedure.

In examining the gums of our patients, it is well to be aware of the general physical condition. This information is often obtained from the physician who sends the patient in. There are many disease conditions the effects of which may be reflected in the gums and which may be first recognized by the dentist, by whom the patient can be advised to consult a physician.

Affections of the gingivae and gums may be simple and confined to the marginal tissues, or more complex and involve the underlying tissues and spread to adjacent structures in the course of the infection. Many forms of gingivitis are due to bacterial invasion and the micro-organisms are distinct.

Simple gingivitis of traumatic, atrophic or hypertrophic origin is not primarily a bacterial disease, but may predispose to secondary infections.

Of the more complex affections associated with the invasion of micro-organisms may be mentioned chronic suppurative pericementitis or so-called pyorrhea, acute ulcerous gingivitis (Vincent's infection, trench mouth, etc.), catarrhal gingivitis and mycotic gingivitis or thrush.

Of those forms of gingivitis associated with systemic diseases secondarily, mention is to be made of those seen in the leukemias (including agranulocytosis), sprue, pernicious anemia, tuberculosis and purpura. Severe gingivitis may occur during pregnancy.

Simple gingivitis may be due to injury of varied origin or to the accumulation of salivary calculus deposits. These conditions progress if untreated, through the stages of inflammation, suppuration and destruction of tissue, in the event of injury, paving the way to a suppurative

detachment of the peridental membrane, with the formation of pockets and, in the event of salivary deposits, resulting in a destruction of the pericemental tissues without pocket formation. The diagnosis is obvious usually, and the treatment of these cases suggests itself.

Catarrhal gingivitis is a form of gingivitis which may occur in association with infections of the upper respiratory tract. There is always a marked increase in the activity of mucous glands. The gums may become swollen and present a shiny surface. The gums are sore and the teeth tender, the condition indicating a generalized local inflammation. Pain is not severe, but the discomfort is marked. Occasionally, herpes may develop, but there is no suppuration or destruction of tissue. Symptoms subside with the control of the respiratory tract infection.

Acute ulcerous gingivitis, known variously as trench mouth, ulceromembranous gingivitis, Vincent's infection, etc., is a disease beginning at the gingivae and rapidly involving the deeper and adjacent structures of the oral cavity. The disease may occur almost at any age, young adults being probably more prone to infection. The disease is caused by the invasion and growth of fusiform bacilli and spirochetes. In children, the infection is likely to be secondary to the acute infectious diseases and to occur in the later stages. In underfed, poorly developed and uncared for children, those who are generally debilitated, the disease may pave the way for the development of noma, in which violent ulcerative and gangrenous destruction occurs, usually involving the cheek. The associated organisms are the same. Noma is a rare complication in adult life.

Thomas L. Gilmer first described acute ulcerous gingivitis in his "Lectures on Oral Surgery," long before the identification of the causative organisms. The disease appears to have become more common since the World War and now appears in a rather more chronic form with an increased resistance to treatment. In the more violent form, the onset is sudden. There is malaise, salivation and rise in temperature, followed quickly by inflammation and ulceration, first confined to the gingivae. It rarely involves the entire gum margin, but rather arises about a tooth here and there, or about small groups of teeth in either jaw or both jaws. The lingual gingivae are not at first involved and rarely if ever become ulcerated. The buccal and interseptal gingivae ulcerate and thus shallow pockets are formed which are covered with a grayish pasty mass, which, on removal, discloses a granulating surface which bleeds easily. The areas thus involved have a ragged edge, soft and thickened and somewhat everted. The adjacent mucosa becomes dark red.

The destruction may progress to the alveolar border and the teeth become loosened. The breath is fetid, the saliva ropy and excessive. The temperature may be elevated to 101-102. The patients betray varying states of anxiety and depression, the appetite is poor, sleep is disturbed and there is constipation. There is no visible pus, but the microscopic examination reveals an abundance of fusiform bacilli, spirochetes and pus cells. The disease involves the submaxillary glands and sometimes the parotid, but the glands do not suppurate. Diagnosis is based on the history of onset and microscopic findings.

It is important to remember that the disease may be associated with pyorrhea and that unerupted or impacted partially erupted third molars may be the reason for recurrent infections of this type. If the infection spreads to involve the oral mucous membranes and the

throat, it should be remembered that diphtheria may be an associated disease.

Peridental disease by whatever name we call it or to whatever school of thought we adhere regarding the etiology is probably better known, not to say understood, by the appellation, "pyorrhea alveolaris." This condition is about the most common affection of the gums that we are called on to recognize and treat. It is important for many reasons. Research investigation and the controversy on the etiology have been energetic and have done much good. The problem of diagnosis is to my mind particularly important from a differential standpoint.

The most frequently occurring conditions which may be confused with peridental disease are acute ulcerous gingivitis and alveolar abscess. Many cases of the former have been treated as "pyorrhea" and cases of peridental abscess have been treated as acute alveolar abscess. The differentiation in these cases is usually definitely made on the basis of thorough mouth examination.

In acute ulcerous gingivitis, there will be malaise with elevation of temperature. There may be no peridental detachments, but the ulceration of the gingivae will usually be unmistakably in evidence. Microscopic examination will reveal Vincent's organisms in abundance. It should not be forgotten that pyorrhea and acute ulcerous gingivitis may be present together and that acute ulcerous gingivitis predisposes to pyorrhea. Submaxillary glandular involvement may occur in both conditions.

Peridental abscesses are usually to be differentiated from acute alveolar abscesses by the presence in the former condition of a pocket which may be explored to the site of the abscess.

Metallic poisoning may cause gingivitis. The most common are mercury, lead and bismuth. In mercurial poisoning, there is marked salivation preceded by complaint of a metallic taste and soreness of the teeth. The gums become swollen, tender and spongy and bleed easily and the breath becomes foul. Extreme cases progress to ulceration and necrosis.

Bismuth causes pigmentation of the gums and oral mucosa. In proportion to the pigmentation, gingivitis, which may progress to ulceration, occurs. Administration of bismuth should be discontinued at the first sign of gingivitis.

Lead poisoning is reflected in the gums by pigmentation, and there are usually accompanying neurologic findings.

Oral hygiene plays an important part in the ability of the patient to withstand metallic poisoning and the manifestations in the oral cavity.

Of the deficiency diseases producing lesions of the gums, there are scurvy, pellagra and sprue, none of them very common.

Scurvy, when well marked, causes swelling, soreness and bleeding. The gums may swell to cover the teeth, and ulceration may occur in severe cases, followed by loss of teeth. The tongue and salivary glands may swell and hemorrhages occur into the mucous membranes.

Pellagra affects the mouth, the gums becoming swollen, the mucous membranes reddened, the tongue swollen and coated. There is an accompanying dermatitis and a psychosis.

Sprue is often accompanied by mouth lesions which may be mistaken for those of acute ulcerous gingivitis. It takes the form of a generalized inflammation of the mucous surfaces, which desquamate, and the necrotic ulcerating areas are absent at the gum margins. In sprue, the gums are affected secondarily.

The gums may be affected secondarily

to diseases of the blood forming organs and the spleen.

Jaundice, from any cause, may be accompanied by bleeding of the gums, but especially is this true in hypertrophic cirrhosis and hemolytic jaundice.

Splenomegalic anemia, aplastic anemia and purpura hemorrhagica all are accompanied by bleeding of the gums.

The first sign of lymphatic or myelogenous leukemia may be seen in the gums. One such case recently came under my care.

REPORT OF CASE

A girl, aged 14, well developed and previously healthy, except for the usual childhood diseases, complained of sore mouth which, in three or four days, rapidly grew worse and was accompanied by a rise in temperature to 102. The family physician had thought the case to be "trench mouth" and had instituted treatment accordingly. With the rapid and marked increase in symptoms, the child was brought to the hospital, where I saw her, in marked prostration. The gums were markedly swollen, of nodular surface and brownish purple streaked with light yellow, a mottled or somewhat variegated appearance resulting. The gums and gingivae were evenly involved around the entire upper and lower arches and covered about one-half the crowns of the teeth. There was a sharp line of demarcation at the junction of the gum and buccal mucous membrane proper, the latter being mildly inflamed and reddened. There were no ulcerations of septal tissue and the gums did not bleed particularly even when touched. Acute ulcerous gingivitis was ruled out immediately because of the widespread uniform character of the condition and the absence of the typical ulcerations around isolated groups of teeth. Diagnosis of acute myelogenous leukemia was made at once when a blood count was made of 250,000 white cells, mostly myelocytes. The patient died three days after admission, seven days from onset.

Of the neoplasms which involve the gums, the epulides are the most common. They are fibromatous or myeloid, the former being most frequently seen. The simple epulis, a benign fibrous tumor, usually pedunculated, but sometimes sessile, is generally seen on the gums in the labial regions. It is of periosteal or peridental origin and may grow to large size, with attendant displacement of teeth. The myeloid epulis develops from the interior of the alveolar bone.

Carcinoma may attack any part of the epithelial tissues of the mouth. The first indication may be irritation and soreness of the gum margin and, local treatment failing to relieve the condition, extraction of a tooth may result in failure of the wound to heal. Such a socket which fails to close and heal within three weeks should be regarded with suspicion, particularly in a person of middle age, and immediate biopsy made. I saw a case recently in which, four months previously, to relieve an irritated sore area around a third molar, the tooth was extracted. Healing did not occur and, when the case was seen, there was an extension of a fungating mass into the floor of the mouth and tonsillar area. Roentgen-ray examination revealed extensive involvement of the ramus. The glands of the neck were stony hard and biopsy revealed squamous cell carcinoma, an inoperable case.

Dr. Gilmer[1] mentions a case in which the condition of the patient involved loose teeth and inflamed gums, which had been attributed by his dentist to pyorrhea and for which treatment was instituted. When seen by Dr. Gilmer, the disease, carcinoma, had involved the cervical lymphatics. It is important to have this possibility constantly in mind.

A distinct affection of the gingivae may occur as a complication of pregnancy. During this period, the bodily

1. Gilmer, T. L.: Some Diseases of Soft Tissues of Mouth, with Differentiation Between Those of Primary and Those of Secondary Origin, J.A.D.A., 14:767 (May) 1927.

resources of the individual are drawn on and, in the event of local neglect and a run-down condition, gingivitis is likely to occur in the last trimester. The condition may also appear or be aggravated during lactation. Usually, it disappears immediately after delivery, but may recur with each subsequent pregnancy.

The cause of the gingivitis is somewhat obscure. DeLee suggests that, during pregnancy, a change takes place in the mouth secretions and that, in addition to the gingivitis, this change favors the growth of bacteria and decay of teeth. In addition, he regards the altered metabolism or the toxemia of pregnancy as, possibly, contributory factors. Williams and DeLee are at variance in an estimate of the frequency of occurrence. The former states that "exceptionally the gums of pregnant women become inflamed and spongy." DeLee's estimate is that in from 50 to 60 per cent of cases, slight tumefaction and hyperemia occur, which may be aggravated to severe infection.

The condition occurs chiefly in the anterior region of the arches. The gums become red, swollen and congested and there is hemorrhage from them. There may be loosening of the teeth. Saliva is not noticeably increased in quantity, the breath is not fetid and there is no complaint of great pain, but of difficulty in mastication as a result of soreness of the gums, rather than a periodontitis. Hypertrophy and polypoid excrescences may appear and there may be ulceration.

Hypertrophy of the gums may occur in various forms and tends to be a chronic condition. It is seen most often in the mouths of young people, but may occur as a result of the chronic irritation of ill-fitting crowns and the unfinished margins of fillings. In young people, it is often associated with gross irregularities of the teeth and with hypertrophy of the pharyngeal tonsils, accompanied by nasal obstruction and mouth breathing.

Buchner, who has recently done work on this subject, suggests that it may be a type of lymphangitis. The gums hypertrophy and take nodular mass formation and encroach on and sometimes obscure the crowns of the teeth, which are frequently separated noticeably. As the condition progresses, fibrous changes take place and the gums become permanently thickened. The gums usually are firm and not greatly changed in color. There is a tendency to bleeding from the subgingival spaces, but no detachment of the pericemental membrane. Infection of these areas may occur, but it is secondary.

Various diseases of the skin are associated with mouth lesions. Embryologically, the skin and front part of the mouth cavity are both of ectodermal origin. Most of these mouth lesions are seen on the mucous membranes, but some tend to spread to the gums. Pemphigus, erythema multiforme and lichen planus may be mentioned in this connection. Usually, they are part of the generalized dermatologic picture, but lichen planus and pemphigus vegetans may be first seen in the mouth.

In lichen planus, the lacelike lactescent markings on the mucous membranes are characteristic.

In pemphigus vegetans, Goadby mentions the involvement of lips, gums and mucous membranes with the occurrence of small whitish or reddish bullous plaques. The bases of these patches become edematous, thickened and inflamed and covered with an offensive viscid secretion.

Gilmer mentions a type of gingivitis often mistaken for pyorrhea, but unsuccessfully treated as such. The gingivitis appears as a brilliant red inflammation

at the gingival crests, the area bleeding freely on being touched, but the peridental membrane is not detached. The condition does not depend on mouth hygiene nor on dietary conditions. Treatment or cure is difficult and the results are disappointing. There is a tendency to recurrence.

The one case I have seen was in the mouth of a young woman, and, in this case, mild alkaline mouth washes were used to bring about a very slow improvement. The culture yielded an unidentified streptobacillus. I have not seen this patient for several months and do not know whether this fact should be interpreted as a cure or an indication of impatience and discouragement.

DISCUSSION

C. J. Caraballo, Tampa, Fla.: For some unaccountable reason, dentists, as a whole, are extremely lax in making an examination of the oral cavity, and errors of omission far exceed those of commission. We are not sufficiently observant, and too prone to "snap judgment" diagnoses. The thorough and systematic examination advised by Dr. Merrifield should reveal any departure from the normal, aiding materially in accurate diagnosis of any given case. As a valuable adjunct to the necessary instrumentarium, I might mention the use of the Cameron or similar lamps as an aid in locating subgingival deposits which might otherwise escape notice. The probing of a fistulous opening with a steel probe, as recommended by Dr. Merrifield, should I believe, be delayed until after roentgenograms of the area are made. Prior to the exposure, a soft guttapercha point should be passed into the fistula, being left *in situ*. The reason for this is that fistulas may originate far removed from the suspected point, and not directly above or below the opening, as the case may be. Overlapping and malposed teeth, which have a bearing on gingival disease, should be annotated on the examination chart. Also, the age of the patient must be seriously considered in relation to diagnosis and prognosis. It is well to note the character and amount of saliva, and, in some instances, secure an analysis. Many times, interproximal caries cause considerable gingival disturbance, with serious results, if overlooked. Gingival hypertrophy, in its varied forms, is often recognized but little understood. Undoubtedly, many common factors enter into the etiology of hypertrophic gingivitis; but different types have distinct causes. I can in no better way emphasize the need of research in the causation of these conditions than by calling attention to Dr. Hirschfeld's exhaustive study of hypertrophic gingivitis which was presented last year before this section.[2] Vincent's disease, I think, in the initial acute stage, is easily recognized. It is the subacute and chronic stages that present so many different forms which are so baffling in attempting a definite diagnosis. My firm belief is that much study is needed to clarify and differentiate these conditions from other types of gingival affections. Dr. Merrifield calls attention to gingivitis of pregnancy. This condition is generally due to the fact that the toxic and altered condition of the patient causes them to neglect daily mouth hygiene. Food débris, together with an increased bacterial growth in the mouth, causes the gums to become hyperemic and inflamed, bleeding on the slightest provocation. In many cases in my office in which we have insisted on regular prophylaxis and strict home care, the gums have remained normal throughout pregnancy and lactation. The average dentist does not readily recognize syphilitic and precancerous lesions. Leukoplakia, which in 30 per cent of all cases may terminate in malignancy, is certainly of sufficient importance to be noted and the patient advised to consult a specialist. Growths or fissures of any kind found in any part of the oral cavity also call for immediate reference to someone able to treat and correct them. Following the recommendations of Dr. Merrifield, let me conclude by urging further research in all soft tissue lesions of the oral cavity and suggest to all present that when unusual cases of interest are observed in office practice, we call in as many of our colleagues as possible to view the condition. It may be that to some the picture is a new one, and visual education, as we all know, is most impressive. Let us observe, compare, reflect and record.

2. Hirschfeld, Isador: Hypertrophic Gingivitis—Its Clinical Aspect, J.A.D.A., 19:799 (May) 1932.

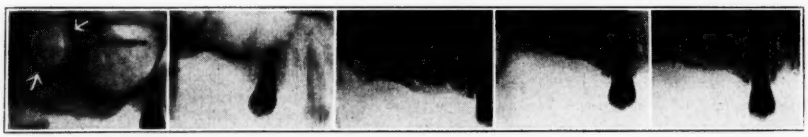
USE OF RADIOPAQUE SOLUTIONS IN THE DIAGNOSIS OF PATHOLOGIC CONDITIONS OF THE MAXILLARY SINUS

By ARTHUR W. VON DEILEN, D.D.S., M.S.D., Atlantic City, N. J.

DIAGNOSIS undoubtedly presents the greatest problem to be found in any of the medical or dental sciences. To arrive at a correct diagnosis, the proper weighing of all the facts in the case is necessary. This is notably true in the diagnosis of disease conditions of the maxillary sinus. There are so many variations in the shape of the normal sinus that one is at a loss, at times, to distinguish the normal from the abnormal.

The maxillary sinus is a cavity which lies in the maxilla. It is in form roughly pyramidal, the apex lying toward the malar bone and the base formed by the lateral wall of the nose. The hiatus semilunaris, the opening which connects the sinus with the nasal cavity, lies high up in the nasal wall of the sinus and opens under the middle turbinate bone in the nose. The antrum is sometimes divided into two or more parts by incomplete bony septums. It is lined throughout with mucoperiosteum equipped with cilia which wave secretions toward the hiatus semilunaris and out into the nose.

This article is not concerned with the acute conditions of the maxillary sinus. These may be diagnosed by the roentgen rays and by observation of the clinical symptoms. What is perhaps more important is the diagnosis of chronic conditions, polypoid degeneration and also the presence of antral cysts. Because of the proximity of the tooth apices to the floor of the sinus, there is great possibility of radicular or root cysts pushing their way into it. In some cases, when this happens, the diagnosis, if the cyst cannot be traced directly to the root of the tooth, is obscure because of the possibility that antral septums are present. Some method must be used that clearly differentiates the antral cyst from a sinus divided by a septum, and clearly demonstrates the thickened antral membrane found in chronic sinus infection.



a *b* *c* *d* *e*

Fig. 1 (Case 1).—Supposed antral cyst, before and after injection of lipiodol. Arrows in *a* show location of supposed cyst. *c*, *d* and *e* show antrum after injection. Complete filling of the antrum shows no cyst present. Thickening of the membrane may be noted.

Shambaugh,[1] in describing chronic antral infection says:

By chronic sinusitis, we understand the development of permanent changes in the membrane lining the antrum. These permanent changes are usually the result of an acute inflammatory process which has become persistent, usually because of inadequate drainage and ventilation through the normal opening. Chronic sinus infection may also be produced through neglected apical disease. Some of these chronic alterations in the membrane lining the antrum are not the result of a persisting acute infection prolonged through faulty drainage; nor are they of dental origin. These are the cases in which there is a polypoid degeneration of the membranes lining the antrum quite like the condition of nasal polypi involving the nasal mucosa. Such cases are not associated with a purulent discharge except as they may become the seat of an intercurrent infection.

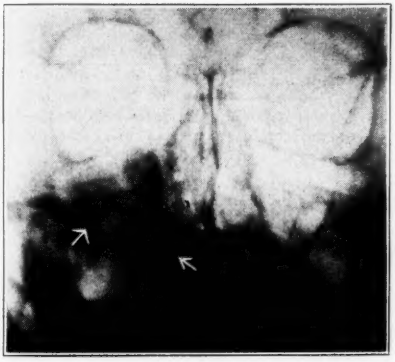


Fig. 2 (Case 1).—Antrum (indicated by arrows) filled with radiopaque solution.

By use of radiopaque solutions injected into the sinus under suspicion, the antral cyst, the thickened membrane, the area of polypoid degeneration of chronic infection and the antrums divided by septums may be clearly and positively demonstrated.

1. Shambaugh, G. E.: Infection of Maxillary Sinus, J. A. D. A., 16:773 (May) 1929.

Proetz,[2] in his book on the subject, describes his displacement method of injecting the sinuses with a radiopaque solution, which I think is applicable only when all the sinuses are under examination. When one of the maxillary antrums is under suspicion, it is much simpler and less confusing to inject the solution directly into that cavity itself.

The solution to be injected is one of the halogenated oils. In 1922, Forestier and Sicard[3] discovered that halogen compounds of certain oils were inert and radiopaque, and could be injected into various body cavities without danger. Ennis[4] states, in a recent article: "The iodized oils are nonirritant, sterilized, radiopaque fluids which may be injected

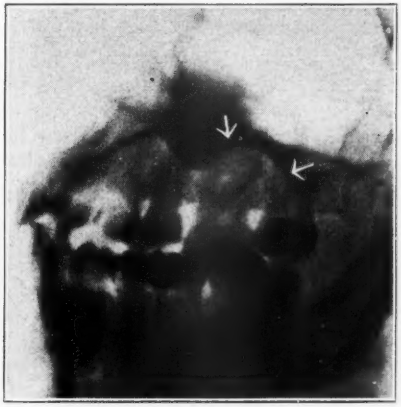


Fig. 3 (Case 1).—Lateral view of case.

2. Proetz: Displacement Method of Sinus Diagnosis and Treatment, St. Louis: Annals Publishing Co., 1931.

3. Forestier, J., and Sicard J. A.: Methode Generale d'exploration Radiologique par l'huile iodee. Bull. et mém. Soc. méd. d. hôp. de Paris 46:463 (March 17) 1922.

4. Ennis, L. M.: Utilization of Radiopaque Solutions in Determining Final Interpretations of Oral Lesions, J. A. D. A., 19:918 (June) 1932.

into the sinuses without causing pain; and, as they are readily absorbed by the tissues, they may be allowed to remain in the injected area indefinitely." Proetz[2] also describes using them in the treatment of chronic sinus disease because of their lubricant properties.

Lipiodol is the oil that is chiefly used, but there are other halogen compounds which are fixed iodin or bromin compounds of some bland vegetable oils. Lipiodol is a fixed compound of iodin, the product of the combination of red poppy seed oil with 40 per cent pure metalloid iodin by weight. These oils may be diluted to as much as 50 per cent with liquid petroleum for injection into the sinuses.

a *b* *c* *d* *e*

Fig. 4 (Case 2).—Supposed antral cyst, indicated by arrows in *a* and *b*. Lipiodol was injected and, in *c* and *d*, the cyst was revealed. *e* shows the condition present after the tooth was extracted and before lipiodol was injected to reveal cyst.

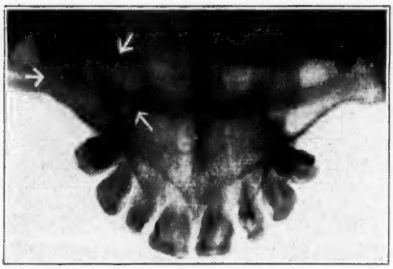


Fig. 5. (Case 2).—Occlusal view of case. Arrows point to the antrum involved. This picture was taken after injection of lipiodol.

TECHNIC FOR INJECTION

The simpler the technic used, the better. It is a comparatively simple matter to enter the antrum with a heavy gage needle through the canine fossa. Careful sterilization of the mucous membrane is necessary because of the risk of antral infection. This possibility is slight if due precautions are taken. A point is selected anterior to the cuspid root and above the lateral root in the canine fossa. The needle is inserted through the overlying tissue to the bone and, with a sharp blow with a mallet, the eggshell thickness of bone over the antrum is pierced, the point of the needle entering the antrum. The needle best suited for this purpose is of the trocar and cannula type, about 16 or 18 gage. A glass syringe is then fitted to the needle and about 3 to 4 c.c. of the radiopaque solution injected. The roentgenograms are then made without moving the patient.

Several authors describe placing a 16-gage steel cannula in the nose and filling the sinuses through the middle meatus. This is hardly practical in the general run of cases because of obstruction of the path that the cannula must take and the difficulty of finding the hiatus semilunaris. Proetz[2] confirms this opinion.

REPORT OF CASES

CASE 1.—Figures 1 and 2 show a case referred by a dentist, showing, to his mind, an antral cyst. As this diagnosis was not accepted, a radiopaque solution was injected through the canine fossa into the sinus under examination. The results of this procedure are shown in Figures 3 and 4. The maxil-

lary sinus and supposed cyst cavity shown in Figure 1 are, in Figure 3, completely filled with lipiodol. This shows that there is a direct communication between the two and that there is, therefore, no cyst cavity present.

The cystic appearance in Figure 1 must have been caused by incomplete bony septums in the antrum. The thickened antral membrane in Figures 3 and 4 can be observed (i.e., the obvious space between the lipiodol and the bony wall of the antrum, a space which must have been occupied by the diseased membrane). Another view of the space occupied by the thickened membrane is also shown in Figure 5.

This series tends to prove that this sinus is not cystic, but, because of the thickened membrane present, is probably the seat of a chronic infection. The clinical examination of the patient also substantiated the view of chronic antral disease.

Figures 6 and 7 are extra-oral views of this case. Figure 6 shows the right antrum filled with the radiopaque solution. Figure 7 shows a lateral view of the same condition.

CASE 2.—Figures 8 and 9 show a case referred by a dentist as an antral cyst. By careful examination, a suspicious area above the second molar roots can be detected, the first molar being missing. This looks like a cyst of some type, but is very indefinite. It would be unwise to operate on such evidence. To help substantiate the diagnosis, lipiodol was injected and the cyst revealed. (Figures 10 and 11.) The curved outline of the cyst and the absence of a thickened membrane in the sinus are evident. The antral membrane in this case appears normal. In this instance, the second molar, because of clinical symptoms, had to be extracted. Therefore, the lipiodol was injected into the antrum through the socket of the extracted tooth. Figure 12 was taken after this tooth was extracted and before the lipiodol was injected. Figure 13 is an occlusal view of the case. On the left side, the outline of the cyst is visible. This picture was taken after the injection of the lipiodol.

I have selected the two foregoing cases as I think that they amply illustrate the point that I am desirous of making. By this technic, many difficulties will be eliminated and many mistakes in diagnosis prevented. Its simplicity and ease of manipulation, together with certainty of results, should certainly result in its more widespread employment. I have never seen any harm result from the employment of this technic, and the non-irritant properties of these solutions should certainly not be overlooked.

1910 Pacific Avenue.

SOME COMMON CAUSES OF FAILURE IN PARTIAL DENTURE SERVICE*

By GEORGE W. WILSON, B.S., D.D.S., F.A.C.D., Milwaukee, Wis.

A REVIEW of dental literature of the past decade gives sufficient evidence to establish the fact that the technic of constructing partial dentures has not suffered from lack of attention by the dental profession. A host of eminent technicians interested in contributing to the welfare of human comfort and the prolongation of life, as well as the satisfaction which evolves from professional service, have labored earnestly and unselfishly. Their diligent and earnest efforts have effected a marked im-

*Read before the Section on Partial Denture Prosthesis at the Seventy-Fourth Annual Session of the American Dental Association, Buffalo, N. Y., Sept. 14, 1932.

provement in the quality of partial denture service. The profession may view with considerable satisfaction the favorable change which has taken place in recent years, both in methods of construction and in ultimate quality of service rendered in this division of professional effort.

The introduction of the casting process in 1907 by Taggart; a broader knowledge of materials and equipment required; a better understanding of the mechanical and biologic requirements of a satisfactory appliance, especially relating to clasp and saddle design, together with a keen interest in the subject by the profession, have been important factors in the development to the present status of the partial denture. Remove from this list just enumerated any one of these fundamental factors and we would still be ignorant of adequate methods of rendering satisfactory service. Despite the attention given and the satisfactory progress made, especially in respect to technical procedure, there is still much to be accomplished, for failures are still commonly observed in the practice.

It is not the purpose of this paper to present or advocate a particular technic for constructing partial dentures. An extensive discussion of failures due to errors in technic, observed in the several particular types of partial dentures, is omitted, because of the variety of mechanical principles promulgated by different technicians. In my opinion, our technical progress is relatively satisfactory. The art of this particular division of dentistry is highly developed. The correlation of the art with the science, the adaptation of the mechanical appliance to the vital tissues and the restoration of impaired function and a more thorough consideration of biomechanical relations are matters to which we should give more attention.

These are the sources from which many serious failures originate and the discussion of them is the primary purpose of this paper. There are two equally important aspects to this problem, the mechanical and biologic. It is not sufficient that we be mere mechanics. It is necessary that we be bio-engineers, as suggested by Dr. Roach, if we are to fulfil the needs of the patient successfully, for we are dealing basically with a combined biologic and engineering problem. The substance of this paper is therefore based on the premise that failure in partial denture service at present is not so frequently due to a lack of mechanical excellence or technical skill, but more frequently to a failure to correlate the mechanical art with the biologic science.

Before proceeding to an enumeration and discussion of some of the common causes of failure in partial denture service, it seems expedient that some of the terms used be defined, in order that specific meaning may be attached to them.

The term "partial denture," within the limits of this paper, is assigned to mean any removable dental appliance which is designed to replace missing natural teeth and restore function and which is supported mainly by the mucosa and underlying maxilla and mandible. The appliance may be constructed with or without attachment to the natural teeth. It may also be entirely supported by the dental ridge or by the ridge and some of the remaining teeth. The partial denture is principally ridge supported. This appears to be the meaning which is generally attached to the partial denture and the particular appliance which we now have under discussion.

"Diagnosis" is another term frequently used in discussions dealing with restorative appliances of this type, and, if taken to mean the act of recognizing the pres-

ence of disease from symptoms, and conclusions as to character, it would seem to be insufficient when used alone, for we are dealing not only with the presence or absence of disease, but also with important problems pertaining to mechanics, where both physical and natural forces must be considered. Diagnosis would apply to procedure preliminary to examining and planning the actual construction of the denture. In addition to the term "diagnosis," which should be used to determine the state of health of the tissues, based on a collection of scientific data and which is all important, we need also to use the term examination or survey. As applied to this topic, survey is used to mean examination and biomechanical planning. It would be more comprehensive therefore, it seems, to use the two terms "diagnosis" and "survey," in a discussion of this subject. The terms, "bioengineering" and "survey" were introduced into this field, I believe, by Dr. Roach. In my opinion, they are entirely comprehensive.

With these fundamental factors in the objective of this paper and the meaning of terms used in this paper established, we may now proceed to the matter of enumerating some causes of failure in partial denture service.

1. From clinical observation, it appears that the general practicing dentist frequently lacks an understanding and appreciation of bio-engineering relationship. Too often, he views the problem only from the standpoint of the mechanic, partially or entirely ignoring the vital functions of the tissues with which he is dealing. The dentist should possess and make regular use of a knowledge of the anatomy, histology and physiology of the tissues of the mouth so that he may build an appliance which will enhance and not interfere with normal health and function. The appliance must be an asset rather than a liability to the tissues which support it. The conservation of the health and function of the teeth and supporting tissues must be maintained. Any appliance, regardless of mechanical excellence, would be in a far better position reposing in the dresser drawer than in the mouth further interrupting function and menacing the health of tissues as well as the comfort and satisfaction of the patient. The establishment of a proper concept of the nature of the whole problem is fundamental, and an essential to success. Some of the items which should be included in a complete diagnosis and which should precede the survey relative to plans of reconstruction are:

(*a*) A complete history of the patient, especially relating to age, occupation, general and oral health, habits of living, environment and mental attitude. Diagnosis is based upon a group of scientific data, and on the accuracy of this depends in large measure the success of the denture. Any good diagnostician will go into the status of the general health of his patient, preparatory to rendering dental service. A physical examination by the physician, including chemicolaboratory tests, may be found necessary in some cases.

(*b*) Investigation of the oral health to determine the fitness of the mouth to receive an appliance. Oral diagnosis is an important step in determining the indications for and contraindications to the use of a partial denture. The health of the remaining teeth and their texture and the form of edentulous spaces must be determined by a clinical examination. The roentgen-ray and vitality tests are useful aids in diagnosis of oral conditions. Is it safe to assume that edentulous spaces do not carry hidden foci which would eventually contribute to the failure of the appliance? Shall we take chances and as-

sume that the roots of remaining teeth are in a favorable state of health to assist in retaining a partial denture?

(*c*) An investigation into the habits of living and the mental attitude of patients. This is of great importance. The partial denture constructed with clasp attachments to aid in retention is frequently condemned because of the increased liability of those clasped teeth to dental caries. The appliance will fail for that reason in the mouth which is not kept habitually clean. The patient with an indifferent attitude toward proper mouth hygiene should not wear this type of structure. To some, this procedure may appear unnecessary, a waste of time and suggestive, at least, of complicating a simple procedure. It must be remembered that the construction and biologic adaptation of this structure is an intricate process, requiring more than mere mechanical skill. Proper consideration must therefore be given to all details which will assist in accomplishing the ultimate objective; that is, service to the patient. A thorough diagnosis, therefore, is just as essential preparatory to the construction of a partial denture as to a surgical operation. We must know our patients to serve them well.

3. A diagnosis of oral and systemic conditions alone is not sufficient in itself to assure success in this type of service. Thus far, we have dealt only with one aspect of the problem. The bio-engineering planning, the correlation of the art with the science, the survey of mouth conditions to determine the type and design of the structure, is the next order of procedure.

The survey should include the taking of impressions and the preparation of study casts. Too often, a casual glance into the mouth, a cursory examination, a snap judgment, a brief description and a proposal of the plan to the patient is thought to be the proper procedure. The problems presented by any mouth for which such an appliance is contemplated cannot be analyzed and intelligent conclusions drawn in this passive, hurried, incomplete manner. Study casts give opportunity to observe the occlusion, number, position and form of the remaining teeth and the shape of edentulous spaces, and, finally, the opportunity to outline the design of the structure for presentation to the patient.

Some of the most difficult problems associated with the design of the case and which are common causes of failure are: the avoidance of excessive strain on the teeth; coordination of action of saddles and attachments, and the use of compensating rests to stabilize the structure and promote function. Impingement of the margins of saddles, bars and clasps on the mucosa must be avoided, and where hard areas are encountered, relief must be provided. An excessive area of clasp coverage on the teeth is a very common cause of failure because it creates great susceptibility to both caries and erosion. An investigation into the form, texture and probable stability of the ridges must be considered.

Partial dentures frequently fail to serve the patient satisfactorily because of the unfavorable form of edentulous spaces. Rough, irregular-shaped ridges such as generally result from the extraction of teeth without surgical preparation for the denture saddles are common sources of failure. Irregular ridges are always unfavorable for the reception of denture saddles because of the excessive tissue resorption and consequent change in form which takes place subsequent to the placing of the denture. This condition results in early and rapid settling of the denture which in turn exerts excessive strain on attachment teeth, with ultimate injury to

them. Fortunately for the welfare of the teeth, the patient cannot tolerate the discomfort which such dentures cause. Alveolectomy is therefore indicated to assure the patient early and satisfactory denture service.

Failure to make an efficient survey and obtain a proper design of the case is one of the most frequent causes of eventual failure.

4. After the diagnosis and survey, a complete, thorough presentation of the case to the patient is another essential to success. It is necessary for the operator to obtain the interest and arouse the enthusiasm of the patient. It is of great mutual advantage to patient and operator to have an understanding relative to plans of reconstruction. This patient education is, in my mind, absolutely essential in order to obtain the intelligent cooperation of the patient. The psychologic factor is of more importance than some seem to think. Neglect to promote in the patient a mental impetus toward understanding the case and the favorable reception of the denture frequently leads to failure in the service attempted. Eventual success in wearing a partial denture is dependent largely on the patient's concept of what the appliance is and some of its limitations.

5. Instructions to the patient relative to the use and care of the denture and postoperative attention by the operator should be considered a part of this type of service. Nothing is permanent; everything changes. Tissue change brings about new relations between the appliance itself, the teeth and the mucosa. New forces are developed which not only interfere with the usefulness of the denture but also endanger the future welfare of the remaining teeth. It is not uncommon to observe clasp cases, the saddles of which have settled under service, exhibiting a tension on the attachment teeth which they cannot tolerate. These teeth are eventually lost and the partial denture, even though once well adapted to the mouth, has finally become a force of destruction instead of usefulness.

Unfavorable conditions frequently develop early in the use of the denture, this depending on the texture of the supporting tissue. A regular periodic check-up of cases would eliminate from the list of failures in partial denture service the vast majority of cases which now fall into that class. A patient for whom a partial denture has been constructed should never be discharged permanently. Dentists frequently fail to teach their patients that, because the tissues of the mouth are constantly changing, the appliance requires periodic readjustment and readaptation to compensate for those changes. We should keep in periodic contact with them.

The matter of proper mouth hygiene should be made clear to one who is about to wear a partial denture. Cleanliness of the denture itself, as well as of the entire mouth, is a prerequisite to success. The dentist should not fail to teach his patients an effective method of keeping clasps and teeth clean and free from bacterial growth. According to our present knowledge, dental caries is the result of bacterial action, and caries under gold clasps can be largely prevented by thorough, regular cleansing. The partial denture is frequently condemned because of damage inflicted on teeth bearing clasps. While it is true that caries and erosion even beneath well formed clasps are among the most common causes of failure in partial denture service, it is equally true that most of them can be effectively prevented by thorough instruction to patients and periodic check-ups subsequent to the placing of the case.

The professional objective of the den-

tal profession is service to the public. Partial denture construction is an important phase of that service. The measure of that service is determined essentially by the attitudes of the dentist toward his objective, the degree of bio-engineering knowledge and skill, and its application to the foundation upon which it is placed. Failure, therefore, to render a satisfactory service is caused by discrepancies in one or more of these important requisites. The majority of failures can be eliminated by frequent contemplation of our methods, an understanding of how improvements can be effected and a desire to place service in the vanguard of our motives.

DISCUSSION

W. I. McNeil, Chicago, Ill.: It is assuring to hear stress being placed on the principles which should be the foundation of every partial denture. There is, as Dr. Wilson explains, sufficient technical advancement to meet the needs of the most complicated and difficult cases. The application of these technics is the most vital question. The terminology brought out by Dr. Wilson as applied to partial dentures is complete. The word "diagnosis" is meaningless when applied in partial dentures. The profession have accepted it and applied it where the word "survey" would be more nearly correct in describing the condition under consideration. I should like to emphasize that we should have a thorough understanding of the tissues from which the partial dentures are to receive their support. Partial dentures are dependent on the following structures for support: the bony process of the maxilla or mandible, the soft tissue overlying these processes and the remaining teeth. To ignore any one of these structures would be a mistake, with perhaps resultant complete failure of the partial denture. The operator's knowledge of these tissues should be thorough both as to formation and the changes which occur under normal conditions as well as under abnormal stresses. Modern developments have made it possible to determine the density of the process and the position of roots of teeth the crowns of which are to be utilized for attachments. This combined with our previous instructions relative to soft tissue formation and its reaction to stimulus should offer fundamental knowledge to which can be added engineering and mechanical principles. These principles as generally understood can be applied with a definite result. In nearly every instance, the materials used react exactly the same. In the construction of a partial denture, the operator attempts to apply these principles in cases the foundation of which is continually changing. It is because of these changes that many partial dentures are failures. If we could determine the amount of absorption, the exact change of soft tissue or the effect on abutment teeth, and compensate for these changes, our problem would be simple and exact. These living tissues are subject to change and are altered by many different conditions over which we have no control; but if we have a thorough knowledge of these tissues, we should be able to adjust our engineering and mechanical principles to the best advantage. All available facts that the patient can furnish in relationship to the general health and habits should be obtained. The operator should not be satisfied until he too has taken advantage of every possible aid in the construction and maintenance of a partial denture. A thorough understanding between patient and operator is essential, no doubt playing a much greater part than most of us realize. Complete confidence in the ability of the dentist helps materially. Mental conversion is just as important as mechanical efficiency. The actual construction of most partial dentures is carried out in dental laboratories. This being true, there remain several steps which the operator should be positive about, namely, survey, design, impressions, materials and installation. Our campaign in relationship to mouth hygiene should not be confined to natural teeth only or be governed by age. Our aim should be a healthy oral cavity under all circumstances, irrespective of what the construction in the mouth may be. Proper instructions and teachings should be a part of the services rendered in all partial denture prosthesis. Our professional purpose is that life may be more abundant and joyful.

AN ANALYSIS OF ANESTHESIA PROBLEMS IN EXODONTIA*

By FRANK W. ROUNDS, D.D.S., F.A.C.D., Boston, Mass.

DURING a recent series of talks, lectures and clinics, a questionnaire was formulated and presented to various groups of representative dentists. A study of their replies and queries convinced me that, in spite of the mass of published material at its disposal, the profession as a whole is not conversant with many fundamental and proven facts a knowledge of which greatly reduces the so-called problems related to this subject.

I have selected a few of the questions as typical of those arising in the mind of any dental audience. The answers are my own opinions and, of course, are the views of a practicing exodontist who is not a scientist or a laboratory worker. Necessarily, they deal with the practical phases of the subject, for most of the anesthetic problems of the exodontist are of a practical and not of a theoretical character.

The questions follow:

1. What are the requirements of an exodontist?
2. Should an exodontist limit himself to one type of anesthesia?
3. Why do most dentists favor local anesthesia?
4. What are the particular indications for and against local anesthesia?
5. What is the most satisfactory general anesthetic in office practice?
6. Why is ethylene or ether sometimes combined with nitrous oxid and oxygen?
7. What preliminary preparation and examination should a patient have for nitrous oxid and oxygen anesthesia?
8. What is the value of carbon dioxid and how is it employed?
9. Will you give some practical hints to aid the general dentist in the administration of nitrous oxid and oxygen?

1. *What are the requirements of an exodontist?*

Exodontia is that phase of dentistry which deals with the extraction of teeth. An exodontist is thought of as one who specializes in, or limits his professional activities to, this phase of practice. The term "specialist" does not necessarily imply superior knowledge, although public opinion expects it, and a person who concentrates on one line of endeavor probably is more proficient than one who diversifies his energies. A general dentist is an exodontist if he extracts teeth.

The patients of today demand and are entitled to a high grade of service in this field, and by this I mean technical skill in the operation, the elimination of undue trauma, minimization of physical or psychic shock, absolute freedom from pain and a due regard for the patient's safety. This, then, necessitates a familiarity with anesthetics and their administration.

*Read before the Section on Oral Surgery, Exodontia and Anesthesia at the Seventy-Fourth Annual Session of the American Dental Association, Buffalo, N. Y., Sept. 13, 1932.

2. *Should an exodontist limit himself to one type of anesthesia?*

In justice to his patients, he cannot. No single anesthetic agent fulfils all the requirements. The operator may have a personal choice because of his limitations, while his better judgment calls for another mode of procedure. He should be versed and proficient in accepted methods. This choice should be based entirely on the patient's best interest, and his decision should be premised by a consideration of the nature of the work to be done; the type of patient from an anesthetic point of view; the physical condition; the mental reaction, and, other things being equal, the patient's wishes. This can be accomplished only by a sound theoretical knowledge supported by a wide clinical experience with the various anesthetics at our command.

3. *Why do most dentists prefer local anesthesia?*

Because they know more about it and are adept in its administration. They are given a thorough training in its theory and practice in the dental school and at graduation are fairly conversant with its use. It requires an inexpensive armamentarium and has a large field of usefulness in general dental operations, and the services of an assistant are not obligatory. Further, in its employment, the life and safety of the patient are not a material factor. Training in general anesthesia has not been featured in college teaching and the average dentist is not an experienced anesthetist. What slight theoretical information he possesses has convinced him that "a little knowledge is a dangerous thing." The responsibility in general anesthetic administration is great, and most dentists do not care to assume this obligation.

4. *What are the particular indications for and against local anesthesia?*

For simple and brief operations, such as an incision or the extraction of loose or deciduous teeth, ethyl chlorid has some sponsors. Its range of usefulness is so limited that it has no universal appeal and it is really only a makeshift. No extended or serious work should be attempted with it.

Of all the synthetic substitutes for cocain, procain has become the standard and accepted local anesthetic. Its field of adaptability in dental practice is large. In exodontia, the operator finds it simple and inexpensive to administer. Physical pain can usually be eliminated. If it is intelligently handled and utilized only when indicated, postoperative hazards are negligible. The patient leaves the office promptly and the anesthetic effect maintains until he has reached home.

If in doubt as to his operative procedure or uncertain in his technic, or if working delicately in an obscure area, the dentist feels that he has ample time at his disposal to conclude his work before the return of sensation. He can rightfully have this same peace of mind if gas-oxygen is employed, for speed is not essential, but if inexperienced in working under or administering general agents, he is apt to feel hurried and nervous and the quality of his work is jeopardized.

Many people are so mentally constituted that they dread narcosis or fundamentally object to losing consciousness. This may be due to some unhappy anesthesia experience caused by an unsatisfactory administration, to a certain religious viewpoint or to the inherent inquisitiveness of others as to just what is going on. Whatever the reason, this reaction exists, and to make satisfied patients should be the objective if there is no serious reason for not doing so.

The phlegmatic and unimaginative are excellent subjects for this method.

If the contemplated operation is not too complicated, if pathologic involvements or mechanical considerations do not preclude, it is eminently satisfactory.

It goes without saying that the well known rules of asepsis in procedure should be carried out. The site of the injection must be sterile, the needle sharp and the agent introduced without pressure. Many topical aids are featured to relieve the patient of the dread of the needle prick, a dread which is surprisingly universal. My own experience has been that, with a sharp point introduced under the pressure of the finger end and the procain gently infiltrated in a mucous fold, the alarm of the skeptical patient is needless and a painless injection made. Delicacy of touch, applied psychology and a practical application of the Golden Rule are essential in administrating any anesthetic, or in any other operative contact for that matter.

There are contraindications. Children, on a whole, are not good local anesthetic patients. Some cooperation is needed if procain is used, and this can hardly be expected of children in general. Frequently, the little patients have a painful or infected lesion to be operated. Loss of sleep is often part of the story. The morale of the whole family perchance has been lowered, and the parent, who invariably accompanies the child, through love, sympathy, worry, lies or what not, has contributed in making a neurotic subject to start with. Whether the agent of choice is local or general, the exodontist will usually attain better results if the parent is eliminated from the scene. The average child can be handled with little difficulty if the truth is told and some finesse employed. Expertly handled gas and oxygen is an ideal anesthetic for such cases. Regardless of age, they invariably react well if the gas is delivered without much pressure and with liberal oxygenation.

The response to either nitrous oxid or oxygen is rapid and the border line between good and poor anesthesia is narrow; but induction is speedy and a proper balance can be easily ascertained. The patient usually recovers with a happy smile. We have added one more family of boosters to our clientele.

While, as before indicated, many people resent the thought of narcosis, probably as many or more welcome it for any surgical operation. The nervous, fearful and neurasthenic types shudder at being cognizant of the procedure, worry over the introduction of the local agent, mistake pressure for pain and are suspicious regarding every move the operator makes. Anyone can do his given piece of work more efficiently if he is not obliged to expend his nervous energy in supporting the morale of the mentally unstabilized patient. Visualize an attempted third molar removal with resultant failure. Trauma has occurred; engorgement of tissue, stasis of circulation, heat, pain, swelling, trismus, gland and throat complications, with all of their accompanying signs, are frequently in evidence, and the tooth is still in *situ*. The dentist who will advocate, or even suggest, another siege with the patient conscious has better courage than judgment. Narcosis for these by all means.

Undoubtedly, you are familiar with the local conditions which preclude procain injections. It is an axiom that the needle must not pass through infected areas. Trismus, false ankylosis, caused by erupting third molars, and acute pathologic involvement, such as cellulitis, osteomyelitis, or other suppurative conditions, absolutely contraindicate its employment. The danger of extending infection or inviting a general blood

stream continuation is always present in such conditions.

The question of anoxemia comes in here. To quote McKesson[1]:

> By any method or agent with which we are familiar today, anesthesia may be the result of anoxemia. How that anoxemia is brought about may differ with the agent. Conductive or local anesthesia undoubtedly gets its action by restricting the oxygen supply, along the nerve trunk (in the case of conductive) and to the tissues direct, under infiltration. Whether temporary ischemia is present or not, the presence of procain, for example, produces a state of local anoxemia. Healing is slower and there is more "after pain." Local anoxemia in a traumatized and infected tissue fosters the progress of partial aerobic infections, such as the streptococcic. The local anesthetic is also capable of producing convulsions and other symptoms of gross or general anoxemia when it is absorbed in sufficient doses.
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> The longer an anesthetic is retained in a tissue after it has served its purpose, the greater is the danger of permanent damage to that tissue. Ether, for example, seldom kills at once if well handled, but it often paves the way by its retention in the body, for the destruction of any damaged organ. Local anesthetics also have the disadvantage of being retained in the tissues for relatively long periods. Nitrous oxid is more quickly eliminated than any other anesthetic.

I feel that the "dry socket" problem in exodontia may have a partial explanation in this quotation. Normal circulation is restored slowly after local injections. During and after nitrous oxid, it is constantly near normal.

We see, then, in this answer, that the exodontist must fit the anesthetic to the case in hand, that the psychic and material factors must be analyzed and that good judgment indicates the measure of success.

1. McKesson, E. I.: Essentials of Nitrous Oxid-Oxygen Anesthesia with Review of Its Use in America, J.A.D.A., 13:411 (April) 1926.

5. *What is the most satisfactory general anesthetic in office practice?*

Nitrous oxid and oxygen as employed today comes nearer approaching our conception of the ideal than does any other agent. Over a long period of years, it has established itself as being capable of producing satisfactory anesthesia when intelligently handled. This ideal which we seek requires simplicity and ease of administration, quick induction, sufficient depth of narcosis, speedy elimination for prompt recovery and freedom from postanesthetic complications. With the practical absence of odor, and with the use of a pleasantly scented inhaler for the ultrafastidious, few patients object to its induction, which may be accomplished so rapidly that the formerly looked for second or excitement stage is now practically eliminated. Utilizing a modern machine capable of delivering the gases under controlled pressure, the operator finds his agents absolutely under his control and anesthesia speedily produced with a minimum of effort.

From the patient's point of view, the border line between consciousness and unconsciousness is crossed without the disagreeable sensations which were formerly so objectionable. Any degree of anesthesia can be attained and maintained by a proper mixture of the gases, which is ascertained by definite and positive signs. These signs clearly indicate the patient's need and are so outstanding that to attain the desired plane is simple. Too light narcosis can be readily avoided, and the danger zone need not be approached.

We were taught years ago that nitrous oxid produced unconsciousness by causing oxygen deprivation. Necessarily, asphyxial signs developed and only short operations could be performed. Recovery was attained by the administration

of atmospheric air. With the addition of oxygen in combination, pronounced anoxemic symptoms are unnecessary.

The generally accepted theory today is that all anesthetic substances act by reducing the oxygen supply to the organism. We know that nitrous oxid, being far more soluble in the blood plasma than oxygen, crowds out the latter in the blood stream, the lymph and, lastly, the cell fluids. Nerve tissue requires far more oxygen than the musculature; therefore, sensation and consciousness are obliterated before an oxygen demand registers in the other tissues and organs. When the muscular signs indicate the need, sufficient oxygen is added to accomplish the purpose and an even narcosis can be maintained.

Nitrous oxid does not decompose and forms no combinations in the system. It has no affinity for the tissues. Its action is purely mechanical. The chief element of safety is the fact that its elimination is exceedingly rapid if oxygen is introduced into the lungs.

Prompt recovery necessarily ensues and a long period of postoperative analgesia is obviated. Nausea is rare and the patient leaves the office in a very few minutes without any possibility of after-complications. As it is nonirritant and noncumulative, lung and kidney involvements, so frequent after the use of the lipoid solvents, cannot follow.

For these reasons, nitrous oxid has a high place in the thought of the anesthetist.

6. *Why is ether or ethylene sometimes combined with nitrous oxid and oxygen?*

Candidly, I do not know, unless the operator is not sure of himself in handling gas and oxygen. There is ample proof that these adjuncts are unnecessary. No better anesthesia can be developed by employing them, and many sound arguments have been advanced against their employment in a dental office.

Ether is primarily a hospital anesthetic. It is not pleasant for the patient on induction, it requires extensive preliminary preparation and premedication and, being a fat solvent, its elimination is exceedingly slow. The prolonged analgesia and frequent nausea following its use upsets office procedure. The odor is permeating and offensive and one ether case can upset the routine for the day.

The risk of pneumonia and kidney irritation demands that the patient be put to bed for a considerable period. A physician's care is frequently advisable and often required. Its employment does not make for pleased patients or comfortable recovery and the need for it is not to me apparent.

The explosive quality of ethylene is in itself enough to condemn its use in the dental office. Like nitrous oxid and oxygen, it is simple to administer and no extra equipment is required. The garlic odor is not pleasing, and the following analgesia is also prolonged, for this anesthetic too is a lipoid solvent. Recovery is necessarily slower, headaches and oppression are not uncommon and nausea is not at all unusual.

I believe that if mental energy is expended by the dentist in mastering nitrous oxid and oxygen as it has been expended by some in search for the easier way, he will find that he needs no synergist. I am convinced that the employment of these agents in an office practice presupposes uncertainty of operating skill and a lack of knowledge of nitrous oxid and oxygen administration.

7. *What preliminary preparation and*

examination should a patient have for nitrous oxid and oxygen?

Undigested food in a stomach invites nausea. The upper alimentary tract should be empty. Our request of the patient is that three or four hours pass between the taking of nourishment and the administration of the gases. Free consumption of orange juice is advocated. Too long a fast is provocative of a "starvation acidosis." The average case requires no longer an interval than above indicated. We sometimes find that if the patient is of an exceedingly nervous type, semidigested food is emitted hours after its intake. For these, a longer period should be prescribed. To insure a good night's sleep preceding the work and to relieve nervous tension, a sedative may be advised. Just prior to the operation, the bladder should be emptied. Care should be taken that the clothing is loose as the patient sits in the chair. This applies particularly to neck and waist, for complete freedom of respiration is essential.

The question of premedication has evoked much discussion. Apparently, no one point of view on this subject will suit every anesthetist. Morphin alone, or combined with atropin or hyoscin, has been a standard premedicament for years. I hardly feel that any one believes this to be necessary as a routine measure. Remember we are speaking of office procedure. Morphin invites nausea and demands more postoperative care. The average case of short duration does not require it. In longer cases, with danger of shock, no one will question its efficacy. If used with discretion, it often proves valuable for alcoholics, the anemic, those suffering from high blood pressure, or hyperthryoidism, neurotics and the overstimulated types in general.

The barbiturates have supplanted it in many offices and, if judiciously employed, probably fulfil the requirements as well. I feel that premedication can be easily overdone and that overemphasis is being placed on it by some. Clark,[2] in his excellent paper read before this section last year, advises premedication in nearly every case, particularly suggesting pentobarbital sodium; this on the advice of Lundy of the Mayo Clinic. I note that his dosage is very small. Without doubt, no harm can come from the moderate amounts that he suggests.

As a profession, we are prone to grasp new suggestions quickly and have been known to become faddists. Because premedication is sometimes necessary and often advisable, it does not follow that it should be utilized routinely, and a word of caution may not be amiss. It becomes easy to overdo it, and overpremedication presents undoubted disadvantages and even dangers. As we improve our gas-oxygen technic, we will proportionately get away from the necessity of these adjuncts. Nerve sedatives are often valuable in postoperative medication.

A complete circulatory and pulmonary examination cannot be expected nor is it necessary as a preliminary to gas administration for the average dental operation. There are few prohibitory contraindications to nitrous oxid and oxygen if carefully handled and the anesthetic signs observed. If the patient is able to come to my office, I have no qualms. We are usually advised of exceptional risks, and when they are noted, the advice of the family physician should be sought if the dentist feels insecure in his position.

Experience in anesthetic administration furnishes much important information as to the patient's condition in a

2. Clark, H. B.: Practical Discussion of Nitrous Oxid Anesthesia, J.A.D.A., 19:470 (March) 1932.

general way and keen observation supplemented by judicious questioning becomes a habit.

For example, marked shortness of breath, irregularity of the pulse, edema of the ankles and a history of infection are cardiac signs which should not be overlooked. Pitting after finger pressure in the tibia, alternating weak and strong heart beats, definite pulse irregularity and labored respiration should put us on our guard against interference with free respiration. Careful induction and the first plane of surgical anesthesia is indicated.

Anemia may be noted by paleness of lips and skin and puffiness under the eyes. Hard and tortuous temporal arteries are indicative of arteriosclerosis. The asthmatic patient presents wheezing and shortness of breath. The hemophiliac will disclose his condition voluntarily. The tuberculous and diabetic are also cooperative and often bring their physician or we are consulted by him. Such cases rarely come to the office if the disease is far advanced. They do not offer contraindications against gas and oxygen, but the anesthetist who is forewarned is forearmed.

It is rare that the presence of a physician is required, although he should always be welcomed. The average medical man can learn a good deal regarding anesthesia from the well trained dental anesthetist, and the judgment of the latter as to the choice of agent to be employed has frequently proved sounder than that of the former. The physician's mind often harks back to the days of straight gas procedure and he is unaware of the safety and innocuous qualities of gas and oxygen in combination.

8. *What is the value of carbon dioxid and how is it employed?*

The early stages of anesthesia are characterized by prolonged inhalations and short exhalations. The third stage develops greater depth and frequency of respiration, which becomes rhythmic, inhalation and exhalation being practically equalized.

If the danger zone is approached, expiration is exaggerated and prolonged, becomes jerky and spasmodic and may be accompanied by phonation. The lack of rhythm in the early planes is caused by a reduced oxygen supply in the inspired gas and at first may be influenced by external causes such as trauma, pain or fright. The proper balance in the third stage is due to a satisfied oxygen demand and the fourth stage signs are clearly anoxemic.

Normal respiration, then, is arrived at by properly balancing the anesthetic agent and the oxygen supply. The value of carbon dioxid in this procedure lies in the fact that it is a pronounced respiratory stimulant. An adequate percentage of carbon dioxid must be maintained in the lungs. To accomplish this, rebreathing is employed and the expired carbon dioxid is thrown back to again irritate the respiratory center.

In the customary short anesthesia in the dental office, even this is unnecessary. Rebreathing is distinctly advantageous in the longer operations as it greatly influences the depth of respiration. Excessive amounts of carbon dioxid overstimulate and cause too deep breathing. This, if maintained, leads to exhaustion and shock. Some operators are routinely combining carbon dioxid with nitrous oxid and oxygen by running it through the machine and are relying on it for resuscitation purposes. We should not forget that excessive amounts of carbon dioxid are dangerous: more than 10 per cent will produce stupefaction and unconsciousness. Death can easily ensue.

The carbon dioxid supply furnished by intelligent rebreathing satisfies all the requirements in exodontia and does not invite the serious consequences of overloading. In the hospital, with anesthesias of an hour or more duration, carbon dioxid has its value.

For resuscitation of the patient who has stopped breathing, the only virtue of carbon dioxid is to irritate the respiratory passages. If one uses a machine capable of forcing oxygen into the lungs under pressure and mechanically inflating them, this stimulation is accomplished with more certainty. Do not be misled by false premises: it is oxygen and not carbon dioxid that resuscitates. As McKesson has aptly remarked,[3] "If the patient will not make his own carbon dioxid out of oxygen, he is dead for sure and no amount of carbon dioxid administered through an inhaler will save him."

After eighteen years of clinical experience with nitrous oxid and oxygen in an office exodontia practice, I see no need for its adoption. Our cases are not heavily premedicated and hence do not need a respiratory stimulant, for the average patient breathes deeply enough for our purposes without premedication. Not much carbon dioxid is lost in the dental case of average duration. Rebreathing absolutely fulfils any requirements without inviting the danger of overdrugging with its unfavorable sequelae.

9. *Will you give some practical hints to aid the general dentist in the administration of nitrous oxid and oxygen?*

Harms has written[4]: "Whether nitrous oxid and oxygen is contraindicated or indicated in any given case depends on the principles of administration and not at all on the cases themselves. Its indications depend on the ability and inclination of the operator and the condition and attitude of the patient."

The grave cases and those of the longest duration best bring out the virtues of these gases.

Satisfactory results depend in large measure on attention to many small technical details. First in importance is a clear airway. This must be maintained. With the impingement of tight clothing eliminated, the patient is seated comfortably in the chair in an upright, or semi-upright position, with the head so placed that there is no constriction of the throat. The hands should lie in the lap and the feet be placed flat on the footrest if one is used. Mental support for the timorous is delicately and unostentatiously employed. A judicious word of encouragement is often supporting and the self-contained and assured manner of one who knows what he is about and is confident of his results is invariably compelling. Too much preliminary conversation defeats its object.

It is understood that the patient has not been kept waiting unduly. Promptness in keeping an appointment is always appreciated. With the assurance that the work is not serious, that it will be perfectly painless and in a few moments will be over, the patient is asked to relax and breath naturally, as in ordinary sleep. The mouth prop is gently inserted, the inhaler delicately applied without pressure and, in no time, he is unconscious. From then on, the much talked of cooperation of the patient is not a factor. The inhaler must fit firmly and definitely, but is not fastened before unconsciousness is reached. If a nasal inhaler is employed after two or three inhalations, a mouth cover is used. Usually the gases are concurrently ad-

3. McKesson, E. I.: Personal communication to the author.

4. Harms, B. H.: Advantages of Nitrous Oxid-Oxygen in Oral Operations, Nebraska M. J., 12:121-124 (April) 1927.

mitted through the mouth cover. The patient should not be disturbed during induction nor even until the beginning of the third stage. Interference by holding the hands, moving the arm or changing the position of the body should be avoided until the possibility of purposeful movements is past. No conversation or noises are permitted as sounds are magnified and misinterpreted in the first and second stages.

After relaxation, restraining straps are applied if indicated. To strap a patient down while conscious or semiconscious is unwise psychologically. I have always used straps as a routine procedure, but, of late, I have become convinced that, in most instances, they are unnecessary. It is wise to use them with the overstimulated type chiefly, to keep him in position and prevent him from injuring himself on awakening after the operation. These straps should be removed before full consciousness returns, and the patient seldom knows that they have been utilized.

A properly applied throat pack is absolutely essential. B grade hospital cotton is preferred to gauze. The purpose of the pack is twofold: (1) correctly balanced anesthesia depends on it, for the ingress of air must not be permitted; (2) it protects the throat from loose, dislodged particles or elusive teeth and keeps blood, pus and mucus from mechanically blocking the airway. Care must be taken in placing it not to force it into the nasopharynx. A good anesthesia can be easily distributed by the spasm that it may engender, as reflexes in this area are not always abolished in dental cases.

The value of well trained operating assistants must be emphasized. No one should attempt to administer the gases and operate as well. Good exodontia practice requires an anesthetist, an operator and an assistant, and the work of these three must synchronize. It is recognized by all that a third party should always be present to safeguard the operator against possible erotic reaction in the patient's mind.

I must here emphasize the fact that nitrous oxid is potent and that a gas machine has no intellect. Two young dentists in my vicinity, enthusiastically experimenting with newly acquired apparatus, have died recently while self-administering nitrous oxid and oxygen. In both instances, they were alone in their offices. In one case, the inhaler was strapped on, in the other, it had dropped away, but the body had so fallen that the head was cramped and the throat muscles were constricted, asphyxia resulting. Incidents such as these should sufficiently warn one that such a procedure never should be attempted and also reinforce the thought that, under anesthesia, clear unobstructed airways must be maintained.

The one danger connected with nitrous oxid administration is prolonged anoxemia, which results in asphyxia. The resuscitating agent is oxygen, no other restorative being indicated. As it has been definitely brought out that respiration ceases long before the heart or circulatory system is seriously involved, the need is for oxygen and not medicinal heart stimulants.

The muscular and respiratory signs are the sure guides as to the patient's condition. Color is not always reliable. The anemic will not become cyanotic and the plethoric are oftentimes become somewhat cyanotic before induction. Cyanosis is only a guide if the other signs are not right.

At the conclusion of the operation, the patient should lie quiescent until he

is stabilized. A basin held under the mouth does away with the necessity of his moving for expectoration in the cuspidor. To obviate nausea, he should be cautioned against swallowing blood. A few minutes in the recovery room, and the anesthetic problem is behind us.

One could greatly amplify and enlarge on suggestions such as these. I am convinced that, as is evidenced by these answers, the continued and increasingly intelligent employment of nitrous oxid and oxygen by the dental profession will advance its status, and that the problems of anesthesia in exodontia will be proportionately minimized as we learn more about it and devote more effort to perfecting its administration, not allowing ourselves to be sidetracked by extremists who are prone to forget that it is admittedly the safest of all anesthetics.

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DISCUSSION

D. P. Snyder, Columbus, Ohio: The true meaning of the term "exodontist" is one who is not only skilled in extraction, but equally skilled in anesthesia, both local and general. I do not understand why some exodontists refuse to give a general anesthetic, depending on an outside anesthetist, unless they do not wish to take the responsibility, or perhaps they lack that degree of skill which is necessary to complete the operation under a general anesthetic. If one is equally skilled in operating under a general anesthetic, it is not necessary to hurry the operation, although a short anesthesia is to be desired, whether local or general. I believe that I can explain why some exodontists give more general anesthetics than do others. It is their type of practice. For instance, we might classify our practice under two groups: In one class, the majority of referred cases come from the dentists; while the remainder come from the physician. If the majority of cases come from the dentists, more gas anesthesias are indicated and employed. These cases are principally acute alveolar abscesses in which several teeth are to be removed; cases of unsuccessful attempt to remove a tooth under local anesthesia; cases in patients who do not take local anesthetics well and in others in which the anesthetic of choice is gas. The other class which the exondontist has to deal with is entirely different. Most of these cases are referred by a physician and the patients are usually ill, with chronic abscesses and devitalized teeth to be removed, and we receive these instructions from the physician: "Remove only one or two teeth at a time." Also, in communities where ether is the principal anesthetic in hospitals, and gas is given only when ether is contraindicated, the physician is not familiar with gas and is prone to keep his patient from taking it. The indications for local and general anesthesia are well covered by Dr. Rounds and I quite agree with him that healing takes place much more rapidly under a general, especially in the mandible. If there is no contraindication to a general anesthetic, it is the anesthetic of choice in my practice. At Ohio State University, we are attempting to give our students a thorough training in general anesthesia. The first requisite for an anesthetist is certainly a thorough knowledge of physiology, of all the general anesthetics and of physical diagnosis, and an ability to recognize a few of the pathologic conditions in which certain anesthetics are contraindicated. Not much effort is made to have the students administer the anesthetic. Their didactic work is one hour a week during the entire senior year. More than 100 anesthetics are given and the class is permitted to watch the administration and ask questions concerning each case. To my mind this training makes better anesthetists than does permitting the student to give the anesthetic without knowing the fundamentals. Machine technic can be acquired when he starts in practice by carefully picking the cases until experience is acquired. Unless contraindicated, pentobarbital sodium and sodium amytal are rapidly replacing morphin in my practice. I find that any patient takes these capsuls with less apprehension than the proverbial hypodermic. There are cases in which the addition of atropin is indicated and this is given with morphin. A contraindication to the use of these sedatives is

hypotension. In the past, our only cause for apprehension were those rawboned red-faced men who came in for gas extraction, but I must say, with all due regard to the female sex, our problems are increasing since smoking and drinking have become so prevalent among women. Some of them, and it is perhaps due to the amount of leisure time they have, become much more addicted to the habit of smoking than men, and their nervous mechanism is becoming greatly impaired. I must say that the quiet phlegmatic person even though a heavy user of tobacco, invariably makes a good anesthetic subject. These sedatives have a definite and permanent place in our practice, although I see no reason that we should use them on every patient. In Dr. Rounds' answers concerning practical hints to the general practitioner using nitrous oxid, he states that good exodontia requires an anesthetist, operator and an assistant. Is this not discouraging to the general practitioner? We cannot expect him to have this much help at his command. Also, some of us who have only an anesthetist think we carry on a pretty successful practice. I do agree that the type and number of assistants helps in determining the choice between local and general anesthesia for our difficult cases. Just a word of warning to the novice anesthetist: While the administration of gas in the skilled hands of Dr. Rounds and the maintenance of a normal plane of anesthesia are comparatively simple, it sometimes becomes quite difficult for the beginner to keep the patient in a normal plane while working on the mandible. We are instructing our students in a definite technic whereby they are taught to support the lower jaw, thus aiding in maintaining a normal plane of anesthesia. Cyanosis may be the most frequent sign of danger, but, in my opinion, the most alarming symptoms of danger are those which are presented by the exhausted patient, whether from anoxema produced by the anesthetic or from secondary anemia due to some chronic infection. Here, we have loss of muscle tone, sallow and deathlike color and usually contracted pupils. We should remember these symptoms in order to recognize them instantly.

Martin L. DeBats, Detroit, Mich.: The idea of a series of questions and answers, conceived by Dr. Rounds for the presentation of his paper, is not only unique, but also tends to clarify many important phases of anesthesia. Through much practice in this field, one realizes that the subject is indeed a broad one and the knowledge obtained therefrom can be imparted only by painstaking cooperation and study. Dr. Rounds' intention is to discuss the problem in such a way so that it will be of particular interest to the general practitioner; and I shall adopt the same point of view, dealing with the preparation of the patient for nitrous oxid-oxygen anesthesia and some signs of anesthesia. Good results are often dependent on careful attention to the details of preparation. We should bear in mind that the patient is the vitally interested person, and because of that fact, easily impressed by courteous treatment and the efficiency of the office personnel. The neat appearance of the office and the professional bearing of the attendants is of much importance. The calm, friendly attitude of the doctors and nurses will help to allay any misgivings concerning the contemplated service. Instructions should be given to loosen tight clothing and to remove collars and strings of beads. The absurdity of attempting to make a case fit the anesthetic is too well known to be enlarged on. It seems unnecessary to use but one type of anesthetic when another is more adaptable. In my hands, conduction or block anesthesia is preferred to general anesthesia for prolonged operative work; for instance, the reduction of fractures, sinus operations and the removal of impacted teeth. Safer results are obtained with nitrous oxid-oxygen when a pathologic condition is present. I do not like to insert hypodermic needles in mouths infected with Vincent's organisms or in gum tissue around abscessed or pyorrheic teeth, for fear of spreading the disease. Firmly attached and multiple teeth can be extracted successfully under a general anesthetic. When surgical measures are necessary, children can be kept under control, and the work accomplished with minimum discomfort, when nitrous oxid and oxygen is the anesthetic agent. Crying children are subject to respiratory spasms accompanied by uneven induction. This condition should be recognized and overcome by increasing the amount of oxygen in the mixture.

Twenty-five or thirty per cent of oxygen is given at the beginning, with a gradual reduction until the proper dosage is reached. This is sometimes called "the back in method." In spite of the common belief that, of the general anesthetics, nitrous oxid oxygen is the safest, we should not accept the word of those salesmen who claim its administration is simple and without danger. Statistics show that there is no absolutely safe anesthetic. In my opinion, safety lies with the man who knows his subject best. Premedication is desirable for highly nervous persons, alcoholics, drug addicts and sometimes athletes. Sedatives, given by mouth, are usually sufficient to control obstreperous patients. The profound reaction from intramuscular administration of morphin is preferred when the case is unusually difficult to handle. One of the objectionable features of this drug is its prolonged postoperative action. Occasional removal of the face mask, which is often preferable during induction, to allow a breath of fresh air, together with a gentle flow of the gases, tends to relieve the sensation of suffocation. Progress from light to normal to dangerously deep anesthesia is rapid with nitrous oxid and oxygen. Administration should not be attempted without a working knowledge of the symptoms seen in each stage. According to McKesson, its action on respiration is of the most importance. Inhalation and exhalation are mechanical and about equal in volume during normal anesthesia. Spasmodic and irregular breathing accompanied by phonation with prolonged expiration signifies deep anesthesia, which may lead to collapse. Increasing the oxygen usually corrects this condition. Unless breathing has ceased, repeated filling of the lungs with clear oxygen is not necessary. Sudden change of dosage precipitates a state of excitement. Oxygen therapy accompanied by artificial respiration is the remedy for respiratory paralysis.

Next in importance are the muscular phenomena. During normal anesthesia, the facial expression is one of quiet sleep, with the muscles having even tonus. Wild facial expression, twitching and jerking movements, marked rigidity, swallowing, retching and vomiting are signs of deep narcosis. The pupils of the eyes are small or medium and fixed, with the conjunctiva insensitive to the touch during normal anesthesia. Sudden enlargement of the pupils, which become irregular in shape, is indicative of dangerously profound anesthesia. The color of the skin varies with different types. Little or no color change is seen in the anemic, while cyanosis is present in the plethoric during normal anesthesia. Color variation is an uncertain guide to safety. To prevent the entrance of foreign material into the trachea or esophagus, the mouth should be packed with either gauze or cotton of sufficient bulk to insure against its suction into these passages. Packs of insufficient size may be forced back, inhibiting breathing, when saturated with blood and mucus. Oversized packs will also interfere with easy respiration. I prefer four thicknesses of gauze, 8 by $2\frac{1}{2}$ inches. There is always danger of forcing loose teeth, crowns and bridges into the throat with the gauze. The duration of nitrous oxid oxygen anesthesia is comparable with that of other general anesthetics, allowing for careful, unhurried operations. Surgical work should be planned in advance of the operation in order to prevent unnecessary delay, and thus reduce the anesthetic period. As a general rule, less discomfort is experienced after short anesthesia. After general anesthesia, I do not like to have my patients moved from the dental chair to the rest room until they are well recovered. An incomplete sense of balance may cause needless alarm, sometimes causing nausea.

A DENTURE TECHNIC APPLICABLE BY THE AVERAGE DENTIST*

By ROBERT R. GILLIS, D.D.S., Hammond, Ind.

(Let it be understood that your essayist writes not as a denture specialist but as a general dental practitioner. He is presenting a technic that has grown through thirty years, the best points selected from many predecessors and colleagues. He claims no originality; claims only consistency of technic and purpose.)

I have spent some time trying to find out who the average dentist is, making his acquaintance, so that our presentation might be properly directed. The IQ scale by which Dr. Sandiford has graded the human family, as represented by a cross-section in any community, seems most applicable in grading dentists, by and large; hence, I venture to grade dentists thus:

0.25	Genius and near genius
6.75	Very superior
13.00	Superior
30.00	High average
Average line	
30.00	Low average
13.00	Dull
7.00	Hopeless

It is obvious that this paper is not directed to or written for the three upper gradings, nor need we waste time with the two lowest. Our effort is directed to that large audience just above and just below the average line, comprising sixty of each 100 dentists.

This group renders more than 60 per cent of all dental service, possibly 80 per cent of the yearly gross.

This paper contemplates only full dentures; that is, full upper and full lower, as a complete case.

Every denture patient at an earlier stage of life probably was possessed of, endowed by Nature with, a fairly near normal, natural denture. But, when this patient comes to the average dentist to procure "a set of teeth," he presents a scant remnant of that former natural denture.

If any natural teeth remain *in situ,* they should be studied and preserved in casts, together with related data that will prove of great assistance in building prosthetic dentures.

Assuming that the patient becomes edentulous, he still presents four items that must be considered: 1. Ridge form. We make impressions of the upper and lower ridges and secure therefrom casts which faithfully reproduce these ridge forms. 2. Ridge relation. By means of "the bite," we determine an acceptable relation between upper and lower ridges; the open space between being the denture space. 3. Condylar guidance. By means of protrusive bite registrations, we are able to determine the individual path indication of each condyle head for each individual patient. 4. "Realeff." An old item; one that is brought to us by every patient; one not recognized by many operators today but due for ac-

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ceptance in about twenty-five years. "Realeff" is a composite word suggested by the late Hanau and embraces "*re*siliency *a*nd *l*ike *eff*ect."

The average dentist has endeavored earnestly to master item 1 from the earliest days of dentistry when our professional pioneers carved dentures from blocks of walrus ivory, down through the material and technical changes of the years until, today, we find nearly all dentists employing either plaster of Paris or modeling compound, or both, to secure ridge impressions.

The average dentist has made little advance in his method of determining item 2, for he still employs "the mash-bite" technic that was the best known in 1840, the birth year of our profession. More elaborate and more accurate, as well as more modern, methods require too great an expenditure of time and effort, in the opinion of the average dentist.

The average dentist has heard of item 3, but it is only a nebulous haze in his mind; and since condylar guidance is not yet accepted, publicly, by 100 per cent of the professed prosthetists, why should he concern himself about it?

Item 4, "realeff," probably never has entered his sphere of consciousness; or, if it has touched at all, perchance it registered about equally with Einstein's theory of relativity. Hence, we pause only to call attention to "realeff" as a fourth item presented by the patient, and beg leave to register the prophecy that this item, perhaps under another name, will be given due recognition some day.

So, up to now in our process of denture construction, the average dentist has scored about 1½ in a possible count of 4.

He takes the case to his laboratory and there, he builds (5) tooth form and (6) cusp form, choosing from a box or tray of stock teeth the size and shape adaptable to the case in hand; but as he selects them and possibly modifies them by stone grinding, we credit him with being the builder; (7) incisal guidance, which was lost with the removal of the natural teeth, the dentist reconstructs *arbitrarily;* (8) compensating curves, which Nature had furnished in the natural denture. The germ of the idea is expressed in the "curve of Spee," but this item embraces considerably more. Harmonizing or correlating the variants presented in the other items, this eighth item is a resultant.

Supposing the average dentist to be that rare fellow who constructs dentures in his own office; he pays scant attention to items 5 and 6, none to 7, and 8 "just happens."

There are about ten chances to one that he relegates all four items of this group to a distant laboratory technician: thus avoiding much hard work and great responsibility, until the dentures are delivered to the patient.

We will be generous and allow his score to register 2 out of a possible 4. He now totals 3½ points of a possible 8 points, or 43 per cent of a possible 100 per cent.

Because of the pliability of human nature and the wonderful adaptability of Mother Nature, the patient may realize almost double the percentage attained by the dentist; so the average dentist "gets by" with such professional service, the like of which would result in defeat in legal service or a funeral in medical service.

I believe it was Dr. Lowell of Harvard who explained why so many men always remain "average," by his estimate that "the average man uses only one-tenth of his mental facilities and only

one-fourth of his physical power." It sounds reasonable.

You have been very indulgent while I laid my premise and painted this rather dark picture of the average dentist's denture attainments. Yet I challenge you to prove it brighter. Now, we will turn to constructive effort in the hope that full denture work may be raised to a higher plane in the average office.

Time limits do not permit more than the mention of such phases as the making of preextraction study casts and records, preextraction roentogen-ray determinations, preparation of the patient psychically and physically and mouth examination with recording of findings.

While these items are indispensable to many denture prosthetists, and of unquestioned value in any denture case, we must pass them now as being more properly applicable in the upper brackets of our scale of dentists. As the average dentist becomes more adept, he will visualize still higher attainments and can then devote further study to these more advanced items.

THE IMPRESSION

The impression is intended to afford us the counterform of the denture-bearing tissues. Its bearing surface and marginal form should be the exact pattern for the like features of the finished denture base, except as to reliefs.

Because the denture-bearing tissues exhibit a considerable range in degree of resistance or yieldability under pressure, and because the muscle-moved border tissues exhibit considerable range of attachment about the ridge area, each case presents its own peculiar problems. Rules may be stated, therefore, only in generalization.

Since the alveolar ridges, together with their mucoperiosteal covering, never were designed physiologically to bear denture bases, we must compromise with Nature when we build prosthetic dentures. We should build the denture base to cover the greatest tolerable area, and it should provide complete and perfect adaptation to its supporting tissues, but without impingement. Areas immediately over and adjacent to nerve and blood supplies must be "relieved" for physiologic reasons, and areas where bony eminences approach the surface must be "relieved" for mechanical reasons.

As for the material used for the preliminary impression, either plaster or compound will serve, in accordance with the personal choice and ability of the operator.

This preliminary impression, upper or lower, or both is called by some operators "a snap impression." The requirement is for something more than that appellation usually implies: it must be a very good snap impression. We term this the preliminary impression because it does not conclusively predetermine the denture form. It is an open mouth impression and, being such, it is not final.

While it is secured usually at a single effort, it must cover just a little greater area at each border than the proposed denture; yet it must not be overly bulky, for we seek to avoid distension or distortion of the border attachments.

The impression tray should be about one-eighth inch larger than the ridge in each dimension. This tray must not perforate or show through the impression material at any point.

For the upper, the impression material must register tissue contact for a full one-eighth inch posteriorly to the base of the tuberosities and posterior border of the hard palate. The buccal and labial borders will be sufficiently formed by extreme forward and backward move-

ments of the lips by the patient while the material is still moldable, movements as in whistling and broad smiling.

For the lower, the impression material must register tissue contact fully over the retromolar area, lingually, to slightly below the mylohyoid ridge. Anterolingually, the form is well determined by having the patient protrude his tongue just over the lower lip for a moment then withdrawing his tongue and pursing his lips about the operator's two index fingers, which stabilize the tray, and maintaining a sucking effort while the material sets. This sucking effort molds the material against the tissues, lingually, labially and buccally, all in the same effort.

Relief in the Preliminary Impression.—We examine the upper denture area carefully for any hard bony eminences, and likewise for any extremely soft flabby ridge tissue, and mark such areas in the impression. With the point of a knife blade, we cut such outlines to a depth of one-sixteenth inch and crosshatch. Then, we use a Kingsley scraper to remove the crosshatched material to the indicated depth.

The lower usually needs only to be scraped out one thirty-second inch in that part which covers the crest of the ridge from right molar to left molar region. The impressions are now treated with a separating medium, if of plaster, and poured. We prefer that the casts be made of stone.

Trial Bases.—When the casts are recovered from the impressions, shellac bases must be accurately adapted and reinforced with stiff piano wire bent to shape, heated, and imbedded in the base material. For the upper, we place this wire reinforcement from tuberosity crest to tuberosity crest and about one-fourth inch from the posterior border. For the lower, we let the wire extend from second molar to second molar just lingually of the ridge crest where it will not interfere with the subsequent placement of teeth.

There are several of these shellac base materials on the market. A little experience will enable the operator to adapt them to the cast without stretching or thinning such material, turning and searing the border portions for ample reinforcement of these parts. Baseplate wax is wholly inadequate and should never be used in this step.

Testing the Upper Trial Base.—We place the upper base in the mouth and observe first that it does not rock, but seats and rests squarely upon the tissues. If it rocks and if it was well adapted to the cast, we have prima facie evidence that the impression was warped and faulty. We *must* repeat with a new impression. We will save time by doing that step over again *now*.

If the base seats satisfactorily, we next observe the posterior palatal border, asking the patient to sound a short "ah, ah, ah." We note to what degree the soft palate lifts from the trial base, and trim the base margin forward until its edge just covers the vibrating line of the soft palate as the patient utters "ah, ah, ah."

There is a possibility that the patient swallowed several times while the upper impression material was plastic; in which event, he depressed that portion unduly. This will result in the trial base's failing to contact at the vibrating line with the soft palate. This can be corrected by noting the degree of deficiency of adaptation, scraping off as much from the cast and readapting the trial base to the modified cast.

With the palatal border satisfactorily adapted to its tissues, we next examine just behind the tuberosities and run the

edge of the mouth mirror gently down the posterior palatal slope of each tuberosity, depressing the soft tissues until we arrive at a definite stop and find the mouth mirror rim in a slight depression. That depression is the proper limit for the trial base in this area, and also for the finished denture base. We trim accordingly.

Next, we hold the trial base gently in place with one index finger, placed midpalatally, while we pull down the buccal and labial tissues by manipulating the cheeks and lip. We trim the buccal and labial border of the trial base until such movements do not dislodge it.

Testing the Lower Trial Base.—We apply the same seating tests to the lower base as directed for the upper base to determine that it does not rock. It is essential that both upper and lower trial bases seat positively to avoid errors that would prove most disastrous later. We trim the lingual borders so that no functional movement of the tongue tends to dislodge the base against the gentle finger pressure. Likewise, we next trim the buccal and labial borders and test as for the upper buccal and labial borders.

DETERMINING RIDGE RELATION (TAKING THE BITE)

With a ruler held lightly against the face, we draw a pencil line on each cheek from the corner of the mouth at rest to the lower border of the ear lobe. This temporarily represents the occlusal plane. Many writers indicate a line from the ala of the nose to the external auditory meatus as being parallel with the occlusal plane. Our line is parallel to their line and has the advantage of more closely approximating the occlusal plane; hence, our preference.

We dry heat a roll of softened modeling compound and sear it to the dried upper trial base, mold it to approximate shape, place in the mouth, and, with a Supplee paddle, make its occlusal surface conform to the plane indicated by the lines drawn on the cheeks, leaving it slightly longer than is thought necessary; then remove and chill thoroughly.

Now, we trim with a sharp knife until contour and length meet the esthetic requirements, anteriorly. If we have preextraction records, this compound bite rim is made to conform satisfactorily to the needs of such records. Without such records, we make the rim practically as long as the upper lip at rest and as full labially as may provide a pleasing contour of the lip.

As to rim height posteriorly, the location of Stenson's duct is a dependable guide for the location of the mesiobuccal cusp of the second molar tooth, and we trim the rim accordingly.

We cut the distal ends of the bite rim aslant so that it cannot interfere with the anterior border of the ascending ramus of the mandible in normal closure of the mouth.

The patient is asked to make the valve sounds, "v" and "f," saying the words, "if, fire, oven, very." The lower lip should make contact with the edge of the rim to produce these sounds effectively, just as the lower lip seals against the incisal edges of the natural upper incisors when we speak these words.

We now carve the occlusal surface of the upper bite rim to a semblance of the anticipated compensating curves. The compound may be warmed slightly and pressed against the concave side of a "template," which is shaped like the surface of an 8-inch sphere.

Vaseline is used on this compound rim to prevent sticking to the lower in subsequent steps.

With the upper bite rim completed to this stage, we put it in the mouth and

follow with the lower trial base. We have the patient say "m, m, m," several times, and note that there is no interference at the distal aspect. Again, we have the patient repeat "m, m," then rest with the lips gently in contact. This is a rest position of the mandible.

That position of the mandible is maintained while we part the lips to discover how much space is to be filled by the lower bite-rim.

Now, we sear and seal a roll of softened compound onto the lower trial base and mold to approximate form; place it in the mouth, and ask the patient to say "m" several times. He will perform awkwardly at first, but soon produces the sound tolerably well with his upper and lower lips making contact quite naturally.

We remove the lower and cool thoroughly; trim off such excess compound as has been squeezed up or out by contact with the vaselined upper rim, and also trim the buccal and labial margins so that they fall one-sixteenth inch inside the like margins of the upper rim.

We are careful that both upper and lower bite-rims are trimmed so that their width, buccolingually and labiolingually, is no greater than the diameter of the teeth to be placed subsequently. Many dentists err by having the bite-rims too broad in this respect.

We now soften the occlusal surface of the lower rim evenly to a depth of one-eighth inch, return to the mouth, repeat the "m, m" and have the patient swallow twice immediately after a third "m."

If we have preextraction records, these are compared with present results.

We now cut a line into the labial surface of the upper rim to mark the median line and, with the lower rim occluded in the mouth, continue the line upon the labial surface of the lower rim. While it is still held in occlusion, we make a scratch line upon the occlusal surface of the upper rim to show the labial and buccal border position of the lower rim.

Next, we test the results so far attained:

1. We have the patient say "m" several times, and rest. While he holds that mandibular position, we gently part the lips to see whether there is a slight opening, from one-sixteenth to three-sixteenths inch, between the upper and lower rims. There should be.

2. We test also by having the patient swallow twice and then rest, and examine as indicated above.

If the space is not evident in these two tests, we soften the lower again (occlusal surface) and close the relation by "m" and the swallowing technic. If too great a space is evident, we add more compound to the lower rim and establish a new level in the same way.

3. We have the patient now repeat the vowel sounds (a, e, i, o, u) distinctly while we watch from the direct front position to see that the median-line markings remain continuous after each such sound, also trying the words "if, fire, shy, sail, church, lurch, birch, basket, moon, mop."

If the median-line markings break continuity after tests 1, 2 or 3, we must seek farther for true centric occlusion.

4. We have the patient say "m" and swallow, holding the rims in occlusion just where the act of swallowing makes them contact.

If the median line marks return to continuity after each vocal effort, the lower rim repeatedly meets the upper rim consistently with the marks scratched on the occlusal of the upper rim, and the patient expresses a sense of a uniform

and equal occluding on both right and left sides, we have attained a ridge relation (or bite) that can be accepted, in which we will establish centric occlusion.

The following discussion might be more properly placed in a more technical paper, but it is so vital that it should not be omitted here.

On this step of denture construction, determining the ridge relation or "taking the bite," nearly all textbooks are painfully silent. The few texts that do more than mention it devote only a few hazy paragraphs to the subject. Therefore, I feel justified in emphasizing it and detailing its method of determination.

My definition of centric occlusion is "the innermost end of the masticatory stroke." Occlusion pertains only to the contact or meeting of the upper teeth with the lower teeth during their functional excursions.

A definition of centric relation is "that relative position of mandible to maxilla which exists when the condyle heads rest gently in their glenoid fossae, regardless of the degree of opening anteriorly." Centric relation pertains only to the jaws. It does not concern the teeth and can be dispensed with except in academic treatises on associated subjects.

Practitioners of prosthetic dentistry have spent many hours in an effort to arrive at agreement on these points, and I would only add confusion now by more extended discussion. Let us merely keep in mind that our whole concern now is with centric occlusion.

Each patient has a masticatory range of jaw movement that is best suited to his own functioning. There is an optimal centric occlusion for each edentulous patient. That we seek to establish.

The movements of mastication are among the involuntary movements of the body. While they may also be made voluntary, by far the major part of masticatory effort is performed without conscious effort. Voluntary masticatory effort is always strained muscular effort; hence, it is not a safe guide for us while seeking optimal centric occlusion. To the degree that the patient injects voluntary muscular effort into the search for centric occlusion, we are liable to find ourselves in error, finally.

Many suggestions have been made in an endeavor to disclose or lead to centric occlusion (a correct bite), and not one of them is infallible. There are several mechanical appliances that would force the mandible to a prescribed course of movement and not one of them is practical and dependable.

Fortunately for the denture builder, there are parallel jaw movements associated with other functions and, by employing such parallel functional movements, we are enabled to arrive at our goal, centric occlusion, even more certainly than by employing masticatory effort or any auxiliary appliances.

The function of speech provides our first aid, as a parallel jaw movement. You will recall that we had our patient say, "m," repeatedly. Try it yourself. You close the jaw, just until the lips meet and, when you have finished the sound, the mandible is in a position of rest. The teeth are not in occlusion. There is what some have called "a free way space" between the upper teeth and lower teeth. If the mandible is not in a rest position, you are conscious of more or less effort being exerted to hold it so.

The function of swallowing provides the second aid and parallel jaw movement. You recall that we had the patient swallow against the warmed lower rim after saying "m" two or three times. Try it yourself. Say "m" and swallow.

Now say "m" and swallow twice, noting how much more effort is applied at the second swallowing effort. With the completion of the swallowing act, the mandible automatically returns to the same rest position as after saying "m."

When you say "m," the teeth do not occlude; while, in swallowing, they do occlude. The difference in length of movement or magnitude of movement of the mandible in these two functions represents the vertical dimension of the "free way space," and this also represents the difference between centric relation (rest position) and centric occlusion (swallowing position). We are concerned only with the latter as our level upon which to begin construction.

In directing the patient, we must avoid any use of the words "shut," "close," "bite," or any other possible terms that might suggest masticatory effort on his part, because, to whatever degree his effort is voluntary, we court error in our findings.

We have used modelling compound for the bite-rims because it is readily conformable and will not become distorted at mouth temperature, as baseplate wax might. It is more dependable than wax in establishing centric occlusion and in transferring and mounting upon the articulator.

When our bite-rims satisfy all tests for centric occlusion, we next mark the high and low lip lines, lines on the upper from the corners of the mouth at rest toward the inner canthus of the eye, and on the buccal surface of the upper rim a scratch is made to indicate the position of Stenson's duct. Next, we cut three or four notches or sharp grooves in the occlusal surface of each rim and carry over onto the buccal surface where they will not interfere with previous markings.

The grooves on the buccal surface afford identifying locks for a roll of compound which is pressed against the entire buccal and labial surface while the patient holds the rims securely in centric occlusion. This lock later enables us to mount the lower properly in relation to the upper rim.

The grooves on the occlusal surface afford identifying locks for a roll of wax into which the patient bites in a protrusive range. This wax enables us to determine the condylar indication and set the condylar inclination of the articulator. In this protrusive bite, we let the magnitude of movement be from about one-fourth to three-eighths inch and maintain the continuity of the median-line marks as nearly as possible. It is advisable to make two such protrusive bites as a double check.

I deem the facebow indispensable in full denture work. Its registration comes next.

1. The fork is adjusted to the upper rim, heated, and inserted so that it will hold securely.

2. Pencil marks are made on the cheek just in front of the auditory meatus to identify the location of the condyle head at centric occlusion.

3. The patient is asked to close and hold the rims while the facebow is adjusted.

4. Contrary to many instructors, it is not necessary to have the two calibrated condyle bars adjusted to the same reading, if enough length remains on both sides to allow for bilaterally equal adjustment to the articulator width. The operator will hold the condyle arm heads over the pencil marks while the patient or assistant tightens the locknut to the fork stem.

5. The condylar arms are now adjusted so that both touch the cheek

tissue with slight and equal pressure. Both must be in proper position over the marks that indicate the condyle head position.

6. The ensemble of bow and upper bite-rim is removed.

ARTICULATOR MOUNTING AND ADJUSTING

We lute the upper cast into its biteplate on the facebow; adjust the sliding condylar arms of the facebow to fit the articulator shaft, making such adjustments bilaterally equal; prop the bow so that the occlusal plane is approximately parallel with the upper and lower rings of the articulator, and secure the upper cast to the upper ring with plaster of Paris.

We lute the lower cast into the lower biteplate, and when the upper plaster luting is well set, carefully unlock and remove the facebow and fork.

We fit the lower rim against the upper rim according to the several markings and compound lock that identifies its proper relation, lute them securely together with wax and then lute the lower cast to the lower ring with plaster, being certain that the articulator is set in its proper centric adjustment when both these casts are attached to it.

When the plaster has hardened, we remove all luting wax and compound lock from the bite-rims; loosen the condylar mechanism of the articulator, and adjust according to the protrusive wax bites.

I am well aware that most dentures today are built with little or no regard for individual condylar indications and that the facebow technic has not been employed. I am also aware that some denture specialists, through their recent writings, advocate simple hinge articulators for setting up of teeth. Such procedure can be sanctioned only for those who understand how to "kick" the teeth into proper alinement at the stage of trying-in; but, for others who are not adept in this "guessing" technic, I recommend the use of an articulator, strictly according to directions; which will provide a dependable guide to the patient's individual needs.

To whatever degree spot grinding with stones and carborundum chewing are necessary to provide balanced occlusion in the mouth, to that degree we have failed in our articulator technic.

SELECTION OF TEETH

Choice of hue and mold of the anterior teeth will be determined by the natural teeth or the patient's recollection of these teeth or by his desire to be changed for the better by the installation of small white teeth or possibly by what the average dentist's tooth stock may afford. In any event, the choice will turn out to be a compromise.

To such degree as the dentist selects low or flat cusps for the posterior teeth, he will minimize his later troubles and also conserve the patient's alveolar ridges for future use.

DENTURE BASE MATERIALS

I shall not go into a theoretical, detailed consideration of the several denture base materials now available. You are probably quite familiar with the many that have been offered recently. Possibly, some of you are also sadly wiser because of practical experience with them.

Vulcanite, which when properly handled, properly cured and properly finished is still the most widely used and most dependable base material, is, in prosthetic work, not unlike amalgam in operative work, being considered cheap material and having been grossly abused. Treat vulcanite properly and, like amal-

gam, it will render remarkably satisfactory service.

Condensites have come and gone and some are being greatly improved in strength and color stability; but they still leave much to be desired.

Celluloid is still celluloid even when called by other names. A trade-name does not relieve it of several treacherous qualities.

New types of metal bases have been introduced. Electrodeposit silver bases, plated over with some of the platinum-group metals, offer the maximum of adaptation of all bases and have but one objectionable feature—discoloration in use.

Swaged bases of stainless steel with vulcanite or condensite rims offer excellent adaptation and unusual strength with a minimum of bulk. For ridges that have become "seasoned," I would recommend a metal base combined with a condensite rim which attaches the teeth and completes the borders. This makes a de luxe case without reaching the high cost of precious metal bases.

TRYING IN

When the teeth are finally set up in a wax that well resists mouth temperature, the case is ready for trying in. These points must be given attention: (1) that an acceptable, balanced centric occlusion is established with even occlusion bilaterally; (2) that compensating curves afford balance in the incisive range and in working ranges on each side; (3) that the patient can function vocally as in those tests made while "taking the bite"; (4) that the patient is satisfied as to the esthetics of the case.

THE FINAL IMPRESSION

I am satisfied that a "closed mouth impression" is more accurate than an open mouth impression. Hence, the first impressions and casts were designated as preliminary.

Now that we have the teeth in the position that they are to occupy, the jaws in the relation in which they are to function, and the border tissues in their optimal functioning position, we are ready to make the final impression.

Rolls of soft carding wax, or its equivalent, about the size of the graphite in a pencil are placed, one each inside the buccal border of the upper rim from cuspid region to heel, seared on with a hot spatula, flashed through a flame to soften, inserted in the mouth and partly placed with the fingers. We then have the patient bite to place with swallowing two or three times. On removal of the upper base, we should have a nice reproduction all along the buccal borders. Any area failing to show contact with tissue demands additional wax and repeating of the mouth effort. With buccal borders correct, we repeat along the palatal border and tuberosities. This is not a postdam impression, but is merely to insure peripheral contact where the preliminary impression may have been lacking. We cut off any gross wax that may have squeezed over the edge and take out any that may have squeezed onto the crest of the ridge; and add enough along the cheek and lip side of the base to make a proper thickness and uniform roll.

Rechecking is done in the mouth to prove that everything is as it should be. Next, we dry the base and crosshatch lightly with a sharp knife point so the final wash impression will adhere better.

One teaspoonful of water is put in a clean, dry plaster bowl and 2 level teaspoonfuls of plastic material is added. The mixture is spatulated thoroughly

and spread uniformly in the upper base, which has now become the impression tray proper. This is carried to the mouth and set lightly with the fingers, and the patient is asked to close in centric occlusion and swallow twice. Centric occlusion is then checked, and the patient directed to hold the denture gently but positively in centric occlusion, while we massage the cheeks and lip downward and inward. Ample time is allowed for setting.

The lower base is removed and any excess fragments of plastic material are removed, the patient rinsing the mouth with cold water.

We now treat the lower base with soft wax rolls just inside the borders of its seating area as was done for the upper base. Lastly, we perfect the adaptation, one side at a time, lingually, posteriorly to the mylohyoid ridge and over the soft triangular pad that is usually found in the retromolar area. We dry, crosshatch and apply the plastic material, using one-half teaspoonful more powder for the lower than for the upper.

When the lower base, which has now become the lower impression tray proper, is seated in certain centric occlusion and the patient has made the swallowing effort, the mouth is opened, the base held gently with an index finger on each first molar and the patient is asked to raise and protrude the tongue just beyond the lower lip for only a moment, then close in centric occlusion again and, while holding in centric occlusion, purse the lips and suck in. This action spreads the tongue and tightens the buccal muscles so as to mold the material all about the periphery, inside and outside. The patient holds thus until tired.

When the plastic material has set, we should not be in a hurry to remove the bases from the mouth. The patient is given cold water to rinse repeatedly; and the débris is removed, any pieces that may be wanted being preserved. Centric occlusion and any other features are checked, for we now have every relation expressed in the bases that we will provide in the finished dentures. If anything proves unsatisfactory, it can be corrected with a minimum of time and effort by repeating at this stage.

Considerable manipulation may be necessary to dislodge these final impressions. There should be no hurry. Cold water should be used frequently and breakage or distortion avoided, as either will prove fatal to the end-results.

When both bases are removed, we again note areas needing relief and treat either the impression by scraping or the ultimate cast by metallic relief forms. Either will answer the purpose, but we must not fail to relieve when necessary.

Several other papers might be written on the succeeding laboratory stages of denture construction, on delivery to the patient, on instructing the patient, and on adjustment service, all equally vital to full success.

CONCLUSION

May I again recommend (1) that the average dentist shall observe carefully all conditions presented by the patient and be more diligent in correctly applying those principles over which he has arbitrary control; (2) that he make use of the correlated functions of speech and swallowing in "taking the bite"; (3) that he absolutely avoid suggesting in any way the idea of "shut, bite, or close" as voluntary efforts; (4) that he learn to coordinate and harmonize his four case factors with

the patient's four, and (5) that he ponder over and apply the suggestion that the final impression be made *only* when all the parts are in functional relation.

Then and then only will the average dentist lift himself above the ordinary, his resultant success having raised him into an upper grade of the dental scale.

THE AMERICAN PLAN TO GUARANTEE EVERYBODY EQUAL OPPORTUNITY TO ENJOY THE BLESSINGS OF SCIENTIFIC DENTISTRY

By CHARLES H. H. RITTER, D.D.S., Los Angeles, Calif.

THERE seems to be no doubt that the world from the human viewpoint is at a critical period in its history and, with the rest of the world, dentistry is, of course, included. In our own country, dentistry has definitely emerged into the national consciousness as a necessity for civilized life as we know it. On the one hand, we have the laity clamoring for its availability to every citizen, while, on the other, we have a dental profession striving in constantly increasing numbers for organized publicity calculated to increase the demand for the services of the dentists as a group.

As things stand at the moment, the situation may be summed up in the statement that the laity as a body is convinced that it needs dentistry but cannot afford it, while the profession as a body feels that the laity can afford it but does not recognize the relative necessity of dentistry as compared with the luxury of cosmetics, shows, fashionable clothes, high powered autos, tobacco, candy, fancy foods and drinks, parties, vacations, gambling and other things in competition with which the dentist constantly finds his services more or less consciously classified by his patients.

As a result, we find the laity formulating its urge more and more coercively in schemes which range from insurance dentistry to state dentistry, and the dental profession straining more and more toward publicity ranging from individual talks before parent-teacher associations and similar bodies to what may be candidly called group advertising.

As is usual in most controversial problems involving the welfare of humanity, both parties are justified in their stand, and only a judicial weighing of facts can bring out the truth and thus point the way to a solution which will be of actual benefit to all concerned.

It is the purpose of this communication to help do this by demonstrating once more that, in the final analysis, education is the only road to the solution of all important human problems; for, after all, education is nothing more nor less than a "leading out" from the darkness of ignorance to the light of truth, and the recognition of truth alone is the premise for all real progress.

In the case of our particular problem,

it seems clear to us as dentists that the laity needs to be educated regarding the truth about dentistry. The only controversial point seems to be: How? And the very fact that the point actually can be and is controversial among dentists shows how sadly in need of education we ourselves are.

To demonstrate this, we need only take an illustration from our everyday lives as citizens and apply the lesson to the problem of educating the public regarding their need for true or scientific dentistry. Thus, what would be your reaction if you were to dial in your favorite radio station tonight and find a manufacturer of ink paste for adding machines sponsoring a skit program calculated to drive home the fact that two and three really make five? How would you react to a bloodcurdling gangster story under the auspices of the American Authors' Association urging you to let your children learn to read? Or a "nice hot jazz number" by the "orchestra" of a typewriter concern to arouse interest in the possibilities of business, social and love advancement to be derived from the ability to write? And, in turn, what would you say if, in due course, as a result of such propaganda over a period of time, you were to find the laity as a body becoming conscious of the fact that the "three R's" are a necessity for civilized life as we know it and consequently demanding that the state take over the responsibility for each individual citizen's problems and requirements as regards "readin', 'ritin', and 'rithmetic," by supplying state calculation to unravel the mathematical tangles, state readers to decipher the long words and state writers to pen that dunning letter, that formal invitation to a house party or that ardent love letter for you, and, of course, have all of your fellow citizens as well as yourself taxed to the bone to pay for the "necessary service"?

The implication should be obvious, and every thinking dentist should also at least begin to suspect that there is a difference in principle between academic education for the satisfaction of serving God, Truth, Humanity, Ideals or whatever you may wish to call that divine urge which makes a doctor (which, in turn, is merely the old Latin word for "teacher") or a rabbi or a priest of a man, and "ethical educational publicity" in competition with quacks and commercial exploiters of ignorance guided by the ulterior motive of Group Interests, Gain, Self Preservation or whatever you wish to call that urge which is the dominant note of what we usually politely call "Business Instinct," but which the novelists and movies more directly and candidly call "Jungle Law."

Knowledge is Power, and our very American Constitution provides that this be vested in the People; and our schools are the only legitimate agency for its dispensation. The knowledge necessary to the public for the control of dental disease by an understanding of its nature and consequences and how and when to use the services of a scientific dentist, which has become as vital as a knowledge of the classical "three R's," must therefore be dispensed through the schools on a basis of equality with them.

As in any other branch of knowledge, the university is the logical agency to take the lead, and so the practical thing for the dental profession to do would be, first of all, to educate those who are in charge of determining the requirements for university degrees, and all of whom are our patients, to the effect that: 1. The organized dental profession as a body possesses today prophylactic, diagnostic and remedial wealth ample to con-

trol dental disease most effectively. 2. The knowledge of the need for the scientific control of dental disease and its consequences is as vital to every individual as a working acquaintance with the three R's. 3. The extent to which either of these two groups of necessary practical knowledge will avail the individual is a purely personal matter, depending on that individual's intelligence; for "you can lead a horse to the water (of knowledge), but you cannot make him drink thereof." 4. The intensity of subjective discomfort even to the extent of real pain incidental to a dentist's personal services grows from zero to positive suffering in direct ratio to the degree of procrastination that a patient will permit himself in maintaining his schedule of visits to the dentist. 5. The intensity of subjective discomfort and pain incidental to a dentist's personal services grows from zero to positive suffering in direct ratio to the extent of the lack of mutual personal interest and human sympathy existing between patient and dentist. 6. The cost of the control of dental disease as well as that of its local and systemic or remote consequences to the individual is in inverse ratio to that individual's parents' knowledge on dental matters before his birth, to his parents' or guardian's enlightenment in these matters during his childhood, and, on his attaining adult life, to his own education, intelligence and strength of character to utilize this education in competition with mere luxuries. 7. The completion of an authentic course on the fundamental facts of dentistry and the scope and nature of dental service, as well as how to insure the utmost personal benefit from them, must consequently be made a requirement for the B. A. and B. S. degrees. 8. Those universities which contain a dental college within their own organization would have no difficulty at all in locating suitable teachers for such a course. The other institutions could easily obtain them by turning to the dental society of their locality.

Once the universities and colleges are teaching our people these fundamental truths, the high schools and grade schools must inevitably follow suit (many of them have already taken the lead), with the result that our people will in due course know that in dentistry "a stitch in time saves nine." And this old truth is really all the lowest grade of still self-supporting and self-respecting intelligence need be truly convinced of, to be able to afford such dentistry as they would then need.

Paupers, of course, are in a different class and must be handled differently, but, thank goodness! America is not yet entirely pauperized. Selfish ignorance and excessive self-indulgence with resultant disease of mind and body are, in the final analysis, the preponderant premise for pauperism, and our people in the aggregate are not quite so ignorant as they would sometimes appear to be. One hasty glance into the mouth of any person coming to us from any country in the world which "enjoys" state or insurance dentistry is all a dentist needs to determine its "blessings." So, before we allow our people to be propagandized into once more following Europe's lead into disaster, let the American dental profession once more take the lead, as it has always done in any crisis touching on its sphere, by solving conclusively this vexed problem as to how to make the necessity for dentistry plain to every worthy member of society, along with the need of food, clothing and housing, all of which depend on the individual's degree of intelligence in *earning* them.

Roosevelt Building.

DISTRIBUTION OF MOTTLED ENAMEL IN THE UNITED STATES*

By H. TRENDLEY DEAN,† D.D.S., Washington, D. C.

THIS paper reports the results of a survey to determine the distribution of mottled enamel in the United States. No reference will be made to a description of the lesion, its histology or work of recent investigators respecting its etiology. For these phases of the problem, the reader is referred to the work of Black[1] and McKay,[2] Williams,[3] Churchill,[4] and Smith, Lantz and Smith.[5] In 1930, McKay,[6] in an article on geographic distribution, listed a number of areas where mottled enamel had been definitely demonstrated. In addition to those listed by McKay, Ackeroyd[7] and Kehr[8] report certain endemic areas in New Mexico and Kansas, respectively. For the furtherance of future study on this problem, McKay also compiled a complete bibliography of the literature on mottled enamel.

METHOD OF SURVEY

This survey was made in the following manner. Letters were addressed to the secretaries of the state dental societies requesting the names and addresses of the secretaries of the various component or district societies within the state. A questionnaire reading as follows was then sent to the secretary of each of the several component societies.

Dear Doctor:

There exists in about fifty-five areas in the United States the enamel dystrophy known

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† Dental surgeon, U. S. Public Health Service.

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4. Churchill, H. V.: Occurrence of Fluorides in Some Waters of United States, J. Ind. Eng. Chem., 23:996-998 (Sept.) 1931.

5. Smith, Margaret C.: Lantz, Edith M., and Smith, H. V.: Cause of Mottled Enamel, Defect of Human Teeth, Tech. Bull. 32, Univ. Ariz., Coll. of Agr., Agr. Exper. Stat., June 10, 1931.

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7. Ackeroyd, W. J. R.: Mottled and Stained Teeth, Mil. D. J., March, 1923, pp. 7-9.

8. Kehr, R. W.: Dental Deficiencies and Drinking Water, J. Am. Water Works Assn., 23:214-229 (Feb.) 1931; Mottled Enamel and Its Occurrence in Kansas (A thesis submitted to the faculties of the School of Engineering and the Graduate School, University of Kansas for the degree of civil engineer), 1931.

as "mottled enamel." The permanent teeth erupt presenting a dead white or opaque appearance, sometimes being pitted. In a high percentage of cases these teeth later take on the characteristic "brown stain." This development dystrophy is peculiar to the native born children of an endemic area, or those taken into the area very early in childhood.

We are desirous of knowing whether this condition exists within the geographical boundaries of your dental society, and would appreciate any data which you might furnish us. If your society is meeting in the near future, would you discuss this matter with the members. If NO cases exist, will you return this questionnaire so that we may likewise have that information.

1. Does mottled enamel occur locally?

2. If present, approximate number of cases?

3. If present, what percentage of native born children and other susceptibles, would you roughly estimate, have it?

4. Are cases from any particular area?

If so, what city, town or county.

5. If any particular area is affected, what type of drinking water is used? (River, artesian, shallow wells, spring, etc.).

A self addressed envelope which does not require postage is enclosed for your answer. Any other information which you might be in position to furnish us concerning this problem would be gratefully appreciated.

Respectfully,

The only exception was that no questionnaire was sent to those societies with almost exclusively urban membership, such as New York City, Chicago and Philadelphia. Of the 415 questionnaires sent to the various district or component societies asking for a report on mottled enamel within the geographic boundaries of their society, 207, or 49 per cent, were returned.

In certain states where the organization of district societies does not completely cover the state, or in states where, for geologic reasons, we desired a more complete report than ordinarily included in a society report, a questionnaire as follows was sent to one or more individual dentists in each county.

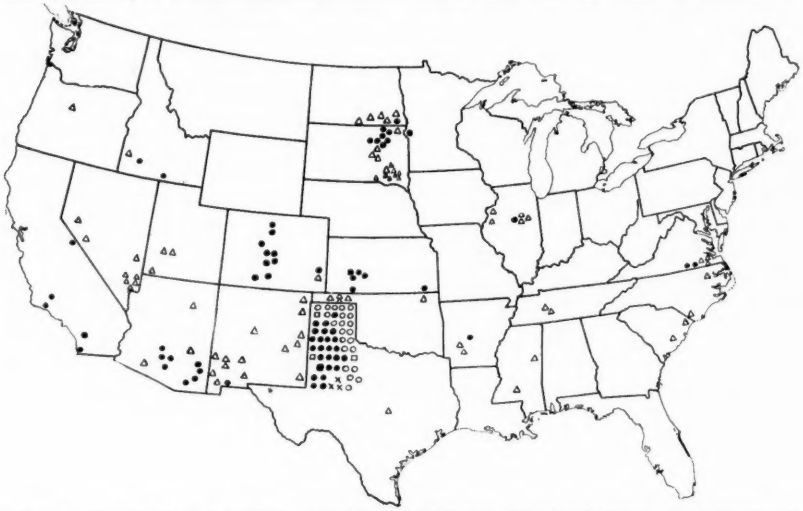
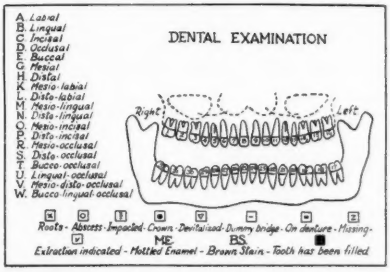


Fig. 1.—Distribution of mottled enamel in United States. The dot indicates areas previously reported in the literature; triangle, new areas reported; circle, areas reported negative for mottled enamel; square, areas receiving questionnaire but not reporting; X, questionable (few cases or indefinite data).

Dear Doctor:

There exists in about seventy-five areas in the United States the enamel dystrophy known as "mottled enamel." The permanent teeth erupt presenting a dead white or opaque appearance, sometimes being pitted. In a high percentage of cases, and in certain areas, these teeth later take on the characteristic "brown stain." This development dystrophy is peculiar to the native born children of an endemic area, or those taken into the area very early in childhood.

We desire to know whether this condition exists within the geographical boundaries of your county and would appreciate any data which you might furnish. If no cases exist, will you kindly return this questionniare stating that the county is negative for mottled enamel.



LOCATION _____ DATE _____

Name: _____ Age: ____ Sex: ____ Color: ____

HISTORY

Residence from Birth in Chronological Order	Duration (Years)	Source of Drinking Water: Municipal	Artesian	Surface well	Spring	Cistern
Birth Place						
1.						
2.						
3.						
4.						
5.						

Brothers or Sisters in the same school. B: _____ S: _____

Remarks: _____

Fig. 2.—Examination chart.

1. Does mottled enamel occur in your county?

2. If present, approximate number of cases?

3. If present, what percentage of native born children and other susceptibles, would you roughly estimate, have it?

4. Are cases from any particular area? If so, what city, town, or part of the county?

5. If any particular area is affected, what type of drinking water is used? (River, artesian, shallow wells, spring, etc.). (In the light of recent research on this problem, the drinking water used from birth to about twelve years of age, or during the period of calcification of the permanent teeth, is apparently an important etiological factor).

Any other information which you might be able to furnish us, either with respect to your own county or some endemic area that you know of, would be gratefully appreciated. A self addressed envelope which does not require postage is enclosed for your answer.

Respectfully,

(The difference between "fifty-five areas" as noted in the first letter and "seventy-five areas" as stated in the second is due to the fact that the latter was prepared at a later date, at which time further evidence of additional areas had become available.)

Fig. 3.—Map of Illinois showing areas previously reported in literature (dot) and new areas reported (triangle).

States where one or more questionnaires were sent into each county included Mississippi, New Mexico, Nevada, Utah and Wyoming. Areas partially covered by these county questionnaires were certain parts of north central Illinois where the water obtained from deep wells and used for domestic purposes showed a high sodium bicar-

bonate content, the Panhandle and West Texas, and rock phosphate areas in Kentucky, Idaho, South Carolina and Tennessee. This same type of county questionnaire was also sent into certain limited areas in Alabama, Florida, Indiana, North Carolina, North Dakota, Oklahoma, South Carolina, South Dakota and Virginia. If Polk's Dental Register (1928) failed to show a dentist practicing in that county, the questionnaire was sent to the county health officer, and, in a few cases, to local physicians. One thousand and thirteen of these individual questionnaires were sent out; 572, or 56.5 per cent, were returned. (Table 1.)

Evaluating a survey of this type is fraught with difficulties. First, all reports which were in the least doubtful were eliminated. Often the answer indicated that the individual was unfamiliar with mottling of the enamel and was confusing it with the hypoplasia. These answers were of course eliminated from further consideration.

TABLE 1.—DATA ON QUESTIONNAIRES

State	Questionnaires to Component Dental Societies	Replies from Dental Societies	Questionnaires to Individuals	Replies from Individuals	State	Questionnaires to Component Dental Societies	Replies from Dental Societies	Questionnaires to Individuals	Replies from Individuals
Alabama	3	1	109	47	Nebraska	8	5	0	.....
Arizona	2	1	0	.....	Nevada	0	.....	35	16
Arkansas	5	4	18	12	New Hampshire	3	1	0	.....
California (State)	15	9	0	.....	New Jersey	12	5	0	.....
California (South)	11	8	2	2	New Mexico	0	.....	73	52
Colorado	10	5	6	4	New York	7	3	0	.....
Connecticut	6	5	0	.....	North Carolina	5	2	40	17
Delaware	1	1	14	8	North Dakota	6	3	38	19
Florida	5	4	26	13	Ohio	24	13	0	.....
Georgia	12	8	13	9	Oklahoma	6	4	15	12
Idaho	3	2	6	2	Oregon	9	5	0	.....
Illinois	24	12	68	42	Pennsylvania	19	13	0	.....
Indiana	14	9	31	16	Rhode Island	0	.....	.....	.....
Iowa	10	4	2	1	South Carolina	4	2	20	9
Kansas	9	3	0	.....	South Dakota	5	1	8	6
Kentucky	9	4	9	7	Tennessee	10	1	32	15
Louisiana	7	2	19	6	Texas	19	11	137	94
Maine	6	2	0	.....	Utah	4	3	52	29
Maryland	5	1	0	.....	Vermont	3	2	0	.....
Massachusetts	4	0	0	.....	Virginia	10	6	17	10
Michigan	14	2	0	.....	Washington	13	6	0	.....
Minnesota	7	3	16	10	West Virginia	12	6	0	.....
Mississippi	4	2	109	55	Wisconsin	27	11	36	21
Missouri	11	5	10	5	Wyoming	2	1	52	33
Montana	10	6	0	.....					
					Total	415	207	1013	572

Secondly, those reporting a very low incidence were likewise set aside as unimportant. On the other hand, when several men in different parts of a county all call attention to a particular area where mottling of enamel is probably endemic, or when local dentists or societies submit extensive reports of local conditions, the evidence becomes of value pending confirmation. It has been impossible to confirm the existence of all of these reported areas by personal surveys, but they are included in this paper as "reported areas" so that others interested in mottled enamel may confirm

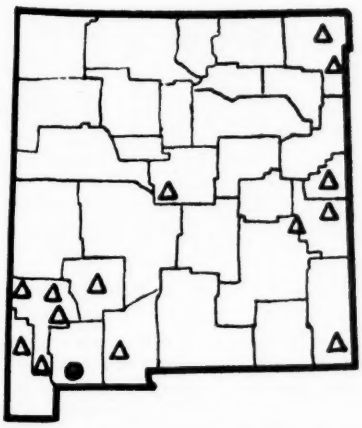


Fig. 4.—Map of New Mexico showing areas previously reported (dot) and new areas reported (triangle).

or disprove them by surveys (Fig. 1). Surveys made by me included Courtland, Va.; Minonk and Fairbury, Ill.; Windsor, N. C.; Conway, S. C., and two rural areas in Hickman and Maury counties, Tennessee. In our surveys, the clinical findings were first recorded, and then the individual history was noted on a card (Fig. 2) provided for that purpose. Of the areas just referred to, Courtland[9] and Minonk[10] have previously been reported in the literature.

SPECIAL POINTS OF INTEREST BY STATES

Arizona.—In addition to the many areas in this state reported by Rodriguez,[11] McKay,[12] and Smith, Lantz and Smith,[5] Leslie W. Foster, field dentist of the Indian Field Service, writing from Keams Canyon, calls attention to the presence of mottled enamel among the Indian children at the Polacca Day School located at Polacca in Navajo County. Fred B. Bass, also a field dentist of the Indian Field Service, writes from San Carlos: "The condition is very prevalent among all the Indians of Southern Arizona, San Carlos Apaches,

Fig. 5.—Map of North and South Dakota and Minnesota showing areas previously reported in literature (dot) and new areas reported (triangle).

Pimas, Papagos and Mohaves. The Apaches live in Gila and Graham coun-

9. Footnote 2. McKay, F. S.: Mottled Enamel: Further Consideration of Endemic Artesian District in Virginia, J. N. D. A. 6:363-370 (April) 1919.

10. Bunting, R. W., et al: Further Studies of Relation of Bacillus Acidophilus to Dental Caries. (Reference to Occurrence of Mottled Enamel at Minonk, Ill.), D. Cosmos, 70:1008 (Oct.) 1928.

11. Rodriguez, F. E.: Mottled and Stained Teeth, D. Items Int., 39:464 (June) 1917.

12. Footnotes 2 and 6.

ties, the Pimas in Pinal and Maricopa counties, the Papagos in Pima county and the Mohaves in Yuma county." Dr. Bass notes that, with the exception of the Papagos, these people obtain their drinking water, in the main, from shallow wells, from 20 to 40 feet deep. He further adds that mottled enamel is prevalent among white people living on the Gila and San Pedro watershed. Smith and Smith,[13] who have made an extensive study of mottled enamel conditions in Arizona, state: "There are at least forty-five communities in Arizona in which mottled enamel is endemic, in degrees varying from 'very mild' to 'severe.' Most of these communities lie along two rivers; namely, the Gila and the San Pedro, the latter flowing into the Gila."

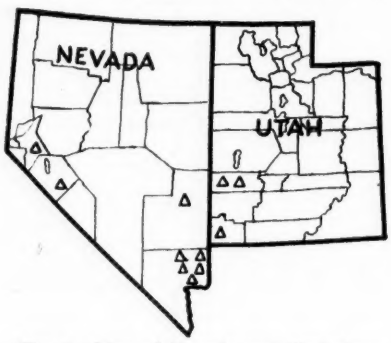


Fig. 6.—Map of Nevada and Utah showing new areas reported (triangle).

Arkansas.—In 1930, Kempf and McKay[14] reported the results of a survey made of Bauxite where mottling of enamel was endemic. In our survey, Gurdon and Okolona in Clark County are reported as endemic areas. Three different dentists call attention to the Gurdon area, two of the reports containing many supplemental data.

Colorado.—The literature[12] records many mottled enamel areas in this state. McKay states that "the largest district of consistent occurrence is included in and adjacent to the Pike's Peak Watershed." The only community reported to us which apparently has not been mentioned in the literature is Hartman in Prowers County.

Idaho.—One questionnaire indicates that mottling of enamel is probably endemic at Wilson in Oxyhee County, apparently being associated with the use of artesian water.

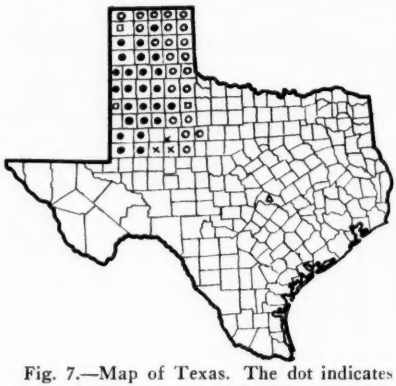


Fig. 7.—Map of Texas. The dot indicates areas previously reported in literature; triangle, new areas reported; circle, areas reported negative for mottled enamel; square, areas receiving questionnaire but not reporting; X, questionable (few cases or indefinite data).

Mississippi.—D. N. Garner, of West Point, writes that mottled enamel is endemic at Brookville in Noxubee County. He reports the examination of 200 school children, and states that the condition is associated with the use of artesian water. Two other dentists re-

13. Smith, Margaret C., and Smith, H. V.: Concentration of Fluorine in Drinking Water in Relation to Occurrence and Severity of Mottled Enamel in Human Teeth, J. D. Res., 12:554-556 (June) 1932.

14. Kempf, G. A., and McKay, F. S.: Mottled Enamel in Segregated Population, Pub. Health Rep., 45:2923-2940 (Nov. 28) 1930.

port mottled enamel as endemic at Monticello and Nola in Lawrence County.

Oklahoma.—Six dentists and a physician report mottled enamel in certain sections of Texas and Beaver counties in the Panhandle. The report of Carl Puckett, managing director of the Oklahoma Tuberculosis and Health Association, contains many relevant data respecting mottled enamel in this region. His tabulations indicate a slightly lower incidence of dental caries among those with mottled enamel than that present in another group in a different part of the state where mottled enamel is not present. Hugh Jeter, of Oklahoma City, calls attention to mottled enamel at Bluejacket in Craig County. Mr. H. J. Darcey, state sanitary engineer, writes concerning the Bluejacket area that the water supply is obtained from individual wells.

Oregon.—The Central Oregon Dental Society reports a small area near Opal City in Jefferson County, known as Opal Springs. The water is obtained from a deep well.

Tennessee.—I have observed mottled enamel in the children of a few families using spring water which traversed rock phosphate beds in Hickman and Maury counties. Although the number examined was few, the incidence was high. Nine of the eleven children showed mottled enamel. This was of particular interest in connection with the work of Velu[15] relative to "Le Darmous" in North Africa. In the opinion of this investigator, "Le Darmous" is due to the ingestion of small amounts of fluorine present as a fluoride in the drinking water due to its passage over or contact with rock phosphate. Velu's description and illustration of this dental dystrophy in human beings leads one to infer that "Le Darmous" is similar to, if not identical with, the condition which we term mottling of the enamel.

Virginia.—In 1916, McKay[2] reported areas of mottled enamel in Franklin and Courtland in Southampton County. In 1919, he[9] reported the results of a survey at Franklin. In 1931, I examined 222 school children at the Courtland school. These children were from Courtland and the surrounding country within a radius of 6 or 7 miles. In this group were twenty-nine children who had lived in Courtland and used artesian water exclusively from birth. Twenty-eight, or 96 per cent, showed definite signs of mottling of the enamel. The one remaining case, listed as negative, was in a 6-year-old child whose erupted permanent teeth were limited to the lower central incisors. The water supply in Courtland is obtained from individual flowing artesian wells. Reports from the state board of health indicate that mottling of the enamel is present at Smithfield (confirmed by W. C. Ames, dentist, of Smithfield), Rescue, Battery Park, and Carrollton in Isle of Wight County, and Chuchatuck in Nansemond County. William L. Smoot, of Williamsburg, writes that practically all native born children on Jamestown Island are affected. He states that artesian water is used for drinking purposes.

The following states, several of which contain well-known mottled enamel areas, will be discussed in some detail: Illinois, New Mexico, North Carolina, North Dakota, Nevada, South Carolina, South Dakota, Texas and Utah.

ILLINOIS (FIG. 3)

Minonk, located in the northeastern portion of Woodford County, was re-

15. Velu, H.: Le Darmous, Arch. de l'Inst. Pasteur d'Algerie, 10:41-118, No. 1, 1932.

TABLE 2.—DATA OBTAINED FROM QUESTIONNAIRES

County	Number of Questionnaires Sent	Number of Replies	Mottled Enamel	Estimated Incidence Per Cent	Water Supply	Remarks
Andrews.....(CHO*)	1	1	Yes	50	Deep wells	No dentist in county; mottling reported in extreme western part of county
Armstrong....(CHO)	1	1	Yes	Low	Deep wells	No dentist in county
Bailey.....(CHO)	1	1	Yes	100	Shallow wells	Joint report for county by CHO and dentist
Borden.....	.....	.....	.....	.....	.....	No physician or dentist listed in county
Briscoe.....	1	1	Yes	Low (valley) High (plains)	? Shallow wells	Severe around Silverton
Carson.....(CHO)	3	1	No	.....	.....	No dentist in county; report from CHO
Castro.....(CHO)	1	1	Yes	85	100-150 foot wells	No dentist in county; general throughout county
Childress.....	4	3	No	.....	.....	.....
Cochran.....	1	0	.....	.....	.....	One MD; no DDS or CHO in county
Collingsworth.....	1	1	No	.....	.....	.....
Cottle.....	3	1	No	.....	.....	.....
Crosby.....	2	2	Yes	50 to 60	100-300 foot wells	General throughout the county
Dallam.....	4	4	No	.....	.....	.....
Dawson.....	5	5	Yes	50 to 95	Shallow wells	Reports from five dentists indicate marked severity
Deaf Smith.....	6	2	Yes	Low	50 to 300 foot wells	.....
Dickens.....	2	2	Yes	Low	?	That part of county around McAdoo
Donley.....	2	1	No	.....	.....	.....

*Indicates that one questionnaire was sent to the county health officer of that county

TABLE 2.—*Continued*

County	Number of Questionnaires Sent	Number of Replies	Mottled Enamel	Estimated Incidence Per Cent	Water Supply	Remarks
Floyd	3	3	Yes	High	100-200 foot wells	
Fisher	1	1	No			
Gaines.....(CHO)	1	1	Yes	75	100 foot wells	No dentist in county
Garza.....(CHO)	2	1	Yes	50	Deep wells	Report received was from CHO
Gray	2	1	No			
Hale	3	3	Yes	90	Deep and shallow wells	Principally from shallow wells
Hall	4	2	No			
Hansford.....(CHO)	1	1	No			Joint report by CHO and local dentist
Hartley	2	0				
Hemphill.....(CHO)	4	1	No			Report received was from CHO
Hockley	2	2	Yes	High	Shallow wells	Those using deep wells reported immune
Howard	5	4	?			Questionable area in NE section of county
Hutchinson	2	1	Yes	50	?	General throughout the county
Kent.....(CHO)	1	1	No			No dentist in county
King.....(CHO)	1	0				No dentist in county
Lamb	1	1	Yes	100	?	
Lipscomb.....(CHO)	2	1	No			Report received was from CHO
Lubbock	13	7	Yes	50 to 75	Shallow wells	A few deep wells noted in reports
Lynn	1	1	Yes	60	Shallow wells	

TABLE 2.—*Continued*

County	Number of Questionnaires Sent	Number of Replies	Mottled Enamel	Estimated Incidence Per Cent	Water Supply	Remarks
Martin.....(CHO)	1	1	Yes	Low	?	No dentist in county
Mitchell.....	3	1	?	Low	Shallow wells	Small questionable area 12 miles NE of Colorado
Moore.....	4	3	No	.....	.....	.....
Motley.....	1	1	No	.....	.....	.....
Nolan.....	5	3	No	.....	.....	.....
Ochiltree.....	2	1	No	.....	.....	.....
Oldham.....(CHO)	1	1	Yes	?	?	No dentist in county
Parmer.....(CHO)	1	1	Yes	?	?	No dentist in county
Potter (two societies).	2	2	Yes	High	Deep wells	Reports from Amarillo and Panhandle Dental Society
Randall.....	1	1	Yes	75	Shallow and deep wells	.....
Roberts.....(CHO)	1	1	No	.....	.....	No dentist in county
Scurry.....	3	1	?	.....	.....	Questionable area in SW section of county
Sherman.....(CHO)	1	1	No	.....	.....	No dentist in county
Stonewall.....	1	1	No	.....	.....	.....
Swisher.....	1	1	Yes	Low	Shallow wells	.....
Terry.....(CHO)	2	1	Yes	.....	.....	Report received was from CHO; no further data
Wheeler.....(CHO)	3	1	No	.....	.....	.....
Yoakum.....	.....	.....	.....	.....	.....	No physician or dentist listed in county
Total.....	122	81				

ported as an endemic area in 1928 by Bunting.[10] During the past year, I examined thirty-nine children at the Minonk school. Twenty-one of these, or 53 per cent, showed mottled enamel. There were nine children who had used the Minonk municipal water exclusively from birth. Five of the nine showed mottled enamel. The city water is obtained from two deep wells. The "old" well is 1,850 feet deep, while the "new" well is reported as reaching a depth of 2,005 feet.

At Fairbury, in the southern part of Livingston County, sixty-eight children were examined, principally from the sixth and seventh grades. Of this group, twenty-one had used Fairbury city water exclusively from birth, and fourteen of these, or 66 per cent, showed mottled enamel. Fairbury obtains its municipal water supply from three wells, 2,100, 2,000 and 1,600 feet in depth respectively.

L. W. Neber, superintendent of mouth hygiene of the Illinois Department of Health, who assisted in the examination at Minonk, reports mottled enamel at Milan, in Rock Island County. The city water is obtained from a 1,100-foot drilled well. This same area was also reported by the Rock Island Dental Society. The Warren Dental Society reports a low incidence of mottled enamel at Monmouth. The water is obtained from wells about 2,000 feet deep.

P. A. Pyper, of Pontiac, reports mottled enamel cases in the surrounding rural districts where deep well water is used. Both he and L. B. Muzzy, of Odell, call attention to mottled enamel in Odell. Dr. Pyper also directs attention to several farms around Emington, about 25 miles northeast of Pontiac, where the inhabitants use deep wells. The children born and reared there show badly marked teeth. W. G. Ross, of Kempton, Ford County, writes that there are many cases in Kempton. It is interesting to note that Kempton is not far from the area referred to by Dr. Pyper around Emington, in Livingston County.

NEW MEXICO (FIG. 4)

In 1923, Ackeroyd[7] reported mottling of the enamel endemic in Columbus. McKay,[6] in a later article on geographic distribution, states, in referring to New Mexico, that it occurs in "various small communities over the state, principally adjacent to the eastern boundary (Texas)," and that there are "no reliable data as to water supply, and no definite knowledge of the particular towns afflicted." There are no component or district dental societies in the state. Seventy-three questionnaires were sent out and replies have been received from fifty-two. Of the thirty-one counties in the state, we have received one or more replies from twenty-nine different counties.

Areas reported are as follows:

Chaves County: J. E. Rose, of Roswell, reports a small area in the extreme northeastern section of the county near Kenna.

Curry County: Luther C. Cox and M. S. Smith, both of Clovis, report mottling of enamel in this county, apparently associated with artesian water.

Dona Ana County: From the reports of S. T. Barnhill and O. H. Brown, of Las Cruces, it would appear that mottling of enamel is general throughout the county, being apparently associated with the use of shallow wells. The data with respect to this county are indefinite, but Las Cruces, the county seat, which obtains its water from wells approximately 200 feet deep, is apparently nonendemic for mottled enamel.

Grant County: Mottled enamel is seemingly widespread throughout this county. L. A. Jessen, of Santa Rita, states that a high percentage of individuals using certain water supplies along the Mimbres River are affected. Frank E. Morton, of Hurley, states that approximately 95 per cent are affected and adds that the water used is obtained from deep hot water wells similiar to artesian wells. W. H. Chapin, of Silver City, reports mottling of enamel in that part of Grant County along the Gila River district. E. J. Thornberry, acting assistant surgeon in the U. S. Public Health Service, states that practically all children of Hachita develop mottling of the enamel. Several of these doctors supplemented their reports with extensive descriptions of local conditions.

Hidalgo County: R. E. Buvens, of Lordsburg, states that about 50 per cent of the children are affected and notes that the water supply is obtained from both artesian and shallow wells.

Lea County: H. J. Coburn, of Tatum, states that mottling of the enamel is general throughout the county and estimates that 90 per cent are affected. He adds that the drinking water is obtained from shallow wells.

Luna County: M. J. Moran, of Deming, writes that mottling of enamel occurs in all the district south of the Florida and Treshermanas mountains, but not in the immediate vicinity of Deming. He states that mottling of enamel is still endemic at Columbus. Dr. Moran further adds that shallow wells are generally used in the areas affected.

Roosevelt County: Raymond W. Means, of Portales, states that a severe type of mottling of the enamel is widely distributed in this county.

Sierra County: A. C. White, the county health officer, states that from 40 to 50 per cent of the children of this county are affected. There is no dentist listed as practicing in this county.

Torrance County: E. S. Hamel, who formerly practiced in Mountainair, estimates that about 25 per cent of the children were affected and notes that deep wells were used for drinking water.

Union County: C. E. Keller, of Clayton, reports about 50 per cent are affected in the town of Amistad, where, he states, shallow wells are used. C. M. Hurley, also of Clayton, states that he finds mottled enamel in those individuals coming from the southern part of the county around Bueyeros and in the northern part around Cuates. Capulin, in the extreme northwestern part of the county, is considered questionable.

No reports were received from De Baca or Mora County. All others were reported as negative.

NORTH CAROLINA

This survey revealed two areas in this state where mottling of enamel is endemic. One is a narrow strip, from 5 to 10 miles wide in Columbus and Brunswick counties, where these two counties border Horry County, South Carolina. The mottling, as in Horry County, is associated with the use of flowing artesian wells. The other area is in Bertie County located in the northeastern section of the state. The county seat of Bertie county is Windsor, a community with a population of 1,425.

I examined 132 children of the sixth, seventh, and eighth grades of the Windsor school. Twenty-two of these pupils had used the Windsor municipal water supply exclusively from birth, and 19, or 86 per cent, showed mottled enamel. The Windsor municipal water supply is obtained from artesian wells.

NORTH DAKOTA (FIG. 5)

In addition to the town of Lidgerwood, referred to by McKay,[6] reports from dentists in Richland, Dickey and Sargent counties indicate that mottled enamel occurs in those individuals around Wyndmere who use artesian water and in those children using artesian water in the eastern part of Dickey County around Oakes, and is more or less general throughout Sargent County wherever artesian water is used. Cayuga and Genesco are particularly referred to in the latter county.

NEVADA (FIG. 6)

As there are no component dental societies in this state, recourse to questionnaires to individuals in the counties was necessary. Points of interest disclosed in the replies were as follows:

Clark County: J. Dayton Smith, of Las Vegas, writes: "In the Moapa and Virgin valleys, about 80 miles from Las Vegas, the native children have mottled enamel almost 100 per cent." The communities affected are: Moapa, St. Thomas, Bunkerville and Overton. The water is obtained from the river and shallow wells. Charles H. Masterson, also of Las Vegas, described the high incidence of mottled enamel in the Moapa valley. E. H. Conger, of St. George, Utah, makes some interesting comments respecting this area. Dr. Conger has an office in Overton, and one at Mesquite, which he visits bimonthly. He writes that the people of Overton get their drinking water from a small stream known as the Muddy Valley River, the source of which is a nearby large spring. In Mesquite, the people obtain water from the Rio Virgin River into which a number of hot sulphur springs drain a few miles from the community. He also states that a large percentage of children of both communities are affected.

Lincoln County: From Caliente, Willard W. Stockham, a physician, writes that about 25 per cent of the children at Panaca are affected. He states that they obtain their drinking water from a spring the water of which is carried in open ditches.

Lyon County: Both E. B. Dawson, of Yerington, and C. H. Masterson, formerly of Yerington but now practicing at Las Vegas, report mottled enamel in this county. The latter noted that a large number of cases came from the "Wabuska district," where the drinking water is apparently obtained from shallow wells.

Mineral County: William J. Lanahan, field dentist of the Indian Field Service, reports mottling of the enamel as endemic in Sodaville, affecting the Whites and Indians alike. The water supply is listed as a hot water artesian well.

SOUTH CAROLINA

This survey disclosed two areas of mottled enamel in South Carolina. W. K. Fishburne, county health officer of Berkeley County, states that he found 297 cases of mottled enamel in eleven schools examined, and he also estimates that these 297 represent about 25 per cent of those examined. In the main, shallow wells are used.

Carl Busbee, president of the Pee Dee Dental Society, reports Conway and Horry counties as endemic areas. I examined this area during the past year. Conway is a community with a population of 3,011 and its municipal water is obtained from three artesian wells. In addition to the city water, there are many flowing artesian wells, not only in Conway but also in the surrounding country. At the white school, the sixth

grade, totaling fifty-nine pupils, was examined. Among these were fourteen who had used municipal water exclusively from birth. All fourteen showed mottling of the enamel, the majority in from a moderate to a severe form. Sixty pupils in the third and sixth grades of the colored school were examined. Those colored children who had used artesian water exclusively showed a mottling of the enamel as severe as in the white children. Other examinations of white pupils at the high school showed that mottling of enamel was fairly widely diffused throughout the northern portion of the county wherever artesian water was used.

SOUTH DAKOTA

McKay[6] reports mottled enamel in Britton, Kidder, Langford, Pierpont, Andover, Groton and, in a general way, Aberdeen. All of these areas are located in the northwestern section of the state and, in each, with the exception of Aberdeen, there is a definite association with deep well water. These areas are located in Brown, Marshall and Day counties.

In addition to the foregoing, areas where mottling of enamel is endemic have been reported to us as occurring in the Whetstone Valley of Roberts County; Conde, Doland and Frankfort in Spink County; Iroquois, Bancroft and Esmond in Kingsbury County; Artesian and Forestburg in Sanborn County; Roswell, Fedora, and Carthage in Miner County and, to a limited degree, at Wagner in Charles Mix County. In all of these areas, the condition is associated with the use of artesian water.

(Since reading this paper, and during a trip through South Dakota in connection with certain other studies, I have found mottled enamel endemic at Vayland, Miller, St. Lawrence and Harrold. In the two latter communities, the dystrophy is of a moderately severe type with a high percentage of brown stain. All cases were apparently associated with the use of artesian water. A total of 221 children were examined in these four communities.)

UTAH

This survey disclosed three areas in this state where mottling of the enamel is apparently endemic. Edgar A. Petty, of Beaver, Beaver County, calls attention to the nearby communities of Greenville and Adamsville. He states that from 700 to 1,000 persons are affected and estimates the incidence at 90 per cent. He adds that the drinking water is obtained from artesian wells and deep springs.

E. H. Conger and W. C. Cox write that mottling of enamel occurs in St. George, Washington County. They state that it formerly was very severe, but, within recent years, there has been a marked decrease in the incidence of mottled enamel locally. This they attribute to the change in the municipal water supply. Formerly the local water supply was obtained from local springs. Later, this supply was supplemented by water brought from the Pine Valley mountains, about 20 miles from the city.

TEXAS

McKay[6] described mottled enamel conditions in Texas when, in a recent article, he wrote: "The distribution over Texas is so widespread that no detailed cataloging of the communities is here possible, but reports indicate that the northwest portion known as the Panhandle constitutes by far the most extensive afflicted area in the country, and involves more people. A definite deep-well association has been reliably established. There are afflicted localities in other parts of the state." A careful

review of the literature failed to disclose what particular communities or counties were affected save that the condition centered around Amarillo and Canyon. During the survey of this state through the component dental societies, the Austin Dental Society reported an area at Taylor, in Williamson County, where, it was estimated, there were 1,000 cases. It was stated that the drinking water was obtained from artesian wells with a sulphur content. Questionnaires addressed to individual dentists at Taylor confirmed this report.

PANHANDLE AND WEST TEXAS (FIG. 7)

In order to obtain as much information as possible regarding the Panhandle and West Texas, a survey by counties was undertaken. Fifty-four counties were included in the area to be studied. In counties where, according to Polk's Dental Register (1928), there was no dentist practicing, or where, after a reasonable time, no reply was received from a dentist listed as practicing there, a questionnaire was sent to the county health officer. In certain instances, there were counties in which no dentist was listed and, in these cases, the sole report was from the county health officer. There were eleven such counties. In four other counties, no reply was received from the dentist listed as practicing there and the data listed in the table were obtained from the county health officer. In two more counties, Borden and Yoakum, it was impossible to find either a physician or a dentist to whom an inquiry could be addressed.

One hundred and twenty-two questionnaires in all were sent into this region, two to the Amarillo and Panhandle Dental societies, and 120 to individuals. Eighty-one replies were received, while four more were returned marked unclaimed, deceased, etc. The percentage of replies, over 68 per cent, was unusually high. Many of these dentists and county health officers supplemented their questionnaire answers with extensive reports respecting mottled enamel in their particular counties. The data disclosed by a study of the replies received from this region are presented in Table 2.

SUMMARY

1. Seventy areas where mottling of enamel is endemic have been reported in the literature.

2. Seventy-three additional localities are listed in this report as "reported areas."

3. Five of these areas, Windsor, N. C.; Conway, S. C.; Fairbury, Ill., and rural areas in Hickman and Maury counties, Tennessee, have been confirmed by personal survey.

National Institute of Health.

PEDODONTIC RESPONSIBILITIES AND OPPORTUNITIES*

By FLOYD E. GIBBIN, D.D.S., Buffalo, N. Y.

IN these days of economic stress and political unrest, when socialized dentistry in various forms is being advocated, it seems a most opportune time to take careful inventory of ourselves —to consider seriously our responsibility to our patients and our opportunity for an increased measure of service.

As time will not permit our consideration of these factors in the broad field of general dentistry, let us confine ourselves solely to one phase of our work—one which has been sadly and most shamefully neglected, namely dentistry for children.

Responsibility means "being answerable or accountable legally or morally for the discharge of an obligation, a duty or trust." Now, just how important, how extensive, is this obligation, this duty which unquestionably we owe our children—our most precious possession, our greatest national asset?

Charles H. Mayo says, "Over 80 per cent of all diseases afflicting mankind has its origin in or through the mouth—61 per cent of all the cases that come to the Mayo Clinic come as the result of mouth infection."

Drs. Sweet, Watson and Stafford write:

"Dental care of the highest grade is necessary if the health problem of the child is to be solved.

"No single health measure counts for more in preventive medicine than the maintenance of a healthy state within the mouth. It is evident that the mouth and its structures are the outposts along the route for the entrance of air and food into the body, and these necessities may at any time carry a cargo of pathogenic bacteria. If the outposts are impregnable, no foothold can be gained and invasion is prevented. On the other hand, if ready lodgment is offered within carious teeth and the diseased tissue that always surrounds them, the invaders find shelter, warmth, moisture and food in which to multiply and await the convenient season for forays into deeper and more vital structures."

The U. S. Public Health Service: "Decayed teeth and septic mouth conditions constitute a large majority of the defects observed in children of school age. Owing to the great number of children who suffer from these conditions, and the frequent harmful effect of such conditions on the physical well being and school progress of the child, and the promptness with which tangible results of corrective work become evident, this work of the Public Health Service stands in the first rank of measures for the conservation of the health of children."

*Read before the Section on Partial Denture Prosthesis at the Seventy-Fourth Annual Session of the American Dental Association, Buffalo, N. Y., Sept. 13, 1932.

Dr. Brewer, physician, states: "Nobody who has even a rudimentary knowledge of preventive medicine will question that dentistry of children stands absolutely first of all measures for the suppression of disease."

Gilman Osgood: "Infection developed in and about the teeth finds a port of entry into the body second to none in importance."

D. D. Smith: "The greatest sanitary reform in the world lies in the task of revolutionizing the unsanitary and infectious condition of the mouth."

Harold J. Leonard: "Oral sepsis 'putrefaction' is the frequent cause of mental retardation and physical debility in children—it increases the tendency to children's contagious diseases—irregularities of the teeth with constricted jaws lead to nasal obstructions, mouth breathing, undeveloped chest and tendency to respiratory disease—dental nerve irritation from dental disease or deformity is a common cause of facial neuralgia and other types of reflex nervous disturbance."

F. Blaine Rhobotham: "Focal infections and their serious consequences are established facts. The child is particularly susceptible and succumbs readily to the deadly effects of these bacteria and their toxins just as heart, kidneys and other vital organs are ruined or impaired in the adult, so also are they impaired in the child and in an increasing ratio. More children die of heart disease than from any other cause and heart disease is the only childhood disease on the increase."

Existing clinical evidence, together with the opinions of foremost medical and dental authorities, is conclusive proof that there is no time in the life of an individual when dental care of the most thorough and the most painstaking kind is more definitely indicated than during the formative period of a child's life. It is far more desirable to build strong boys and girls than it is to repair grown men and women.

This, then, is our responsibility to the 45,000,000 children in this country. How well have we discharged our obligation to them? How well have we fulfilled the trust reposed in us by the parents of these children?

Let us face the facts as they exist. From the White House Conference on Child Health and Protection, we learn that 98 per cent of the children in this country are in need of dental attention; 74 per cent never have had any attention given the mouth and teeth; 24 per cent have had some work done; only 0.2 per cent have complete dental attention; only 1.8 per cent have perfect teeth; 80 per cent suffer from major or minor defects of occlusion and only 2 per cent receive orthodontic treatment.

The question next arises as to just who is responsible for this deplorable situation. The issue can be sidestepped with various alibis, but in the last analysis, it is the dental profession. In the light of present-day knowledge of the seriousness and far-reaching effects of neglect, if we fail to impress its importance forcibly on the mind of the parent, it would seem that we are not only shirking our responsibility, but actually approaching the point of dishonesty. As one views the splendid progress made in other branches of our profession, why is it that dentistry for children has been so sadly neglected? Lack of interest, lack of knowledge, the idea that it is unprofitable, an unwillingness to spend the effort and time to interest parents, all contribute largely to the situation. Wal-

ter T. McFall, associate editor of the new department of dentistry for children in the *International Journal of Orthodontia* hits the nail squarely on the head when he says:

> The dentist who does not keep up, who is not doing his part, is doing irreparable damage to our profession as well as losing his own community's respect and confidence.
>
> The individual dentist is doing more to hurt and hinder the progress and glorious possibilities of mouth hygiene and children's dentistry by his indifference, his continuous failure to do his work well, his unpardonable lies to parents and children, than is any other agency. Such lies as: "The first teeth are not important; it is not necessary to fill and save baby teeth as they will be shed anyhow; abscessed teeth are not a probable source of trouble to children; the sixth year molar does not need to be filled when an explorer easily gets lost in the occlusal surface; it will be all right to wait until the cavity becomes larger, the tooth is not through growing yet." You do not know how much damage and doubt you cause by such false and untrue statements to parents and children who believe in and trust you implicitly. It places the laity in such a quandary they do not know what or whom to believe, and many times they are forced to doubt the importance of dentistry or its efficacy to aid them to be healthy. The situation is not only illogical and unjust, but truly it places the dental profession in a most ridiculous position before the public. We certainly owe it to the children to care for them and until this realization sears itself into our inner consciousnesses, we can not feel we are keeping faith or helping as we should with this, our greatest asset—children.
>
> Seriously now, what do the people of your community know of the importance of deciduous teeth, why the child's first teeth should be cleaned periodically, every effort made to maintain every deciduous tooth until time for normal resorption and replacement, why a child is forced to miss his grade, be sick, slovenly, retarded because of defective teeth? What are you doing to tell and teach parents that dentistry is not a luxury, that sickness costs money, that dental prevention is better, safer and more sure than dental repair and a whole lot cheaper, that childhood is the most trying time in a person's life, that dentistry is a health service and one of the greatest aids to health, good looks, comfort and usefulness in life?

Without doubt, the greatest obstacle to progress is our own mental attitude. If we could only whole-heartedly believe that there is no time in the life of an individual when dental care of the most thorough and painstaking kind is more definitely indicated than during the formative period of a child's life; if we could only believe that dental decay is nothing in the world but disease seeking an entrance into the body; if we could only realize that the cost of dental neglect is far greater than the cost of prevention. When once we shall have convinced ourselves of these fundamental truths, the battle will be half won. We must enthusiastically believe in dentistry for children ourselves before we can convince our patients of its value.

During the past year, much agitation has been focused on proposed educational publicity. Much already has been done through the press and radio and by schools, government and social welfare agencies; yet the statistics previously quoted would seem to indicate that all of these educational efforts have been far more successful in acquainting the public with the bad effects of neglected teeth than in actually persuading the public to do something about it. It seems obvious that the missing link in this situation might be ourselves. Aren't we overlooking a most valuable means of patient education; namely, what we as individuals can do in our offices? The word "doctor" has its derivation from the Greek, meaning "teacher." How many of us live up to this meaning? Just think of what we could accomplish if every dentist were earnestly preaching

the gospel of the importance of adequate dental care for children. Much has been said about "the public being out of step with dentistry." It seems far more logical that dentistry is out of step with the public. Are we doing our part? Are we above reproach ourselves? Take the attendance at the average dental meeting. If a paper on denture or inlay work is scheduled, a large attendance is generally assured, but if the paper deals with dentistry for children, the attendance will diminish about 90 per cent. The indifference to the child problem, the general lack of interest, would seem to indicate that along with all of our education of the public, a certain measure of education of ourselves might not be amiss.

Lack of knowledge is an important factor in this situation. F. Blaine Rhobotham clearly points out the wide field that it encompasses:

> When a broader view is taken, it presents a field of service which requires the greatest diagnostic and technical ability. It includes embryology, diet, child management, child psychology, study of habits, operative dentistry, prosthetic dentistry, therapeutics, anesthesia, extraction, minor oral surgery and pathology. All of these phases are intimately associated with the permanent as with the deciduous teeth. It deals with the normal development of the jaws and face. It is concerned with general health problems as they may be affected by oral impairment. It presents opportunities to practice preventive dentistry at the most effective period. Neglect in childhood often spells opportunity forever lost.

As a profession, are we all well qualified in this respect? Existing conditions would seem to indicate the contrary.

The economic aspect of the situation looms large in importance. "Can't be bothered—no money in it" seems to be the universal objection. When practice is restricted to the extraction of aching teeth, this might possibly be true. But this is far from the modern conception of dentistry for children. Adequate knowledge, facilities and attention to this all-important field will add substantially to any practice. There are no doubt quite a few practices that would have welcomed an increase in earnings from a new source during the last three years.

We will be rewarded with more than a hand-to-mouth existence if we will include the children in our private practice. We seem to forget that children are great boosters. They influence the grownups, who in turn help to fill our appointment books.

Besides bringing joy to our hearts, children bring dollars and cents to our ledgers.

I am intimately acquainted with a substantial number of practices which have enjoyed an increase in income during the last three years. It has been accomplished, not through high fees, but rather through extending the scope of service—dentistry for children. In other words, if we would like to earn more, we must give more.

Let me plead not for a high fee nor for a low fee, but for a reasonable fee, a fee which fits the pocketbook of the parent. Common sense is necessary in this matter of fees. We are told that less than 30 per cent of our population receive dental service. Undoubtedly this percentage includes people with better incomes. On the other hand, it is reasonable to assume that the more we extend this percentage of people receiving dental care, the more we are reaching a class of people with limited incomes. Are we going to so organize our practices that we will be able to care for these people, or are we going to allow socialized dentistry to step in and discharge

the responsibility and usurp the opportunity which is ours?

There is ample proof to substantiate the statement that most of our troubles are within ourselves. I believe the dental profession can and will solve this problem. A real menace exists to the public as well as to the profession in the attempt to put dentistry on a "big business basis."

Common sense management of our practices will aid tremendously in the solution of our problems. If we are to meet successfully our added responsibilities, we must employ the services of others for that portion of our work which they can do as well as we can. There are only about 10,000 dental assistants in the United States as compared with 70,000 dentists. This makes only one assistant for every seven dentists. We must have capable, well-trained assistants to care for the many details of practice, thus leaving our time free for more productive effort. The dental hygienist can play an important part in meeting our problem. In the well-organized practice, the laboratory technician can be of great service. We can and must develop executive ability to meet our added responsibilities.

If we could only get a clear vision of the tremendous opportunity which is ours; an opportunity for service in the conservation and maintenance of the health of the future citizens of our great nation, and an opportunity for improving the economic status of our profession. Picture the vastness of that opportunity: 45,000,000 children with only 70,000 dentists to care for them—over 600 children to every dentist. Thaddeus P. Hyatt, working with the actuaries of the Metropolitan Life Insurance Company, tells us that every single minute of the day there are 2,000 bicuspid and molar teeth erupting in the mouths of the children in this country. For a complete day of twenty-four hours, it means that there are 2,880,000 bicuspids and molars erupting, to say nothing of the anterior teeth. What are we doing to conserve and maintain these teeth in a state of health? Practically nothing.

It is only too evident that we have the "cart before the horse," so to speak. Only 20 per cent of our population are over 40 years of age. Does not our full and partial denture and bridge work, etc., come mostly from this group? Of our total population, 75,000,000 are under 25 years of age, and in this group lies our greatest opportunity for real service—prevention.

The opportunity is ours: what will we do with it? We cannot stand still—we must progress. Stephen Girard once said, "No bank will ever be a success until it has a president who takes it to bed with him at night." It is exactly the same with our work. It calls for vision, inspiration, enthusiasm, study, thoughtful application, self-improvement, hard work and plenty of it.

So let us remember our responsibility which carries with it not only a desire to serve, but also the opportunity to be of service and the developed ability to serve. Our reward will be better mental, moral and physical health, greater self-respect, more respect from our fellow men, larger financial rewards, the realization of an ideal and the greatest degree of true happiness.

DISCUSSION

James J. Ailinger, Buffalo, N. Y.: **My limited experiences as a general practitioner paying particular attention to dentistry for children has proved to me that many points of Dr. Gibbin's paper will bear emphasis. "Why is it that dentistry for children has been**

so sadly neglected?" Let us not make excuses for the dental profession for the mistakes of the past, for its lack of interest. Fortunately, we have seen the light, and many of the obstacles, such as its being unprofitable, the difficulties of child management, and poor parental cooperation, are gradually being overcome by a decided change in attitude of our fellow practitioners during the last few years. True, in part, the dental school has been to blame for the absence of compulsory children's work and, in many cases, the student was given his degree not realizing his responsibility and the wonderful field open to the young dentist in building up his practice largely with child patients. A decided improvement has been made in this line, and it will be only a short time before all dental courses will have dentistry for children as part of its compulsory work. As regards the falling off of attendance at dental meetings when a paper is presented on dentistry for children, I believe that this may have been the case a few years ago, but now there are more papers being read and accepted with an increased attendance and with enthusiasm. Educational publicity? Yes, all we can get; but the public is now far ahead of dentistry along this line. The orthodontist will tell us, when a patient is referred back for operative work to the general operator, that the work was rarely completed and, many times, only about 25 per cent was done. School nurses complain that most dentists dismiss children with many cavities and, often, with infection present. It is our responsibility to supply space maintainers where premature extraction of deciduous teeth is necessary. It is also a responsibility not only to refer malocclusion cases to the orthodontist, but also to insist, wherever possible that the case be so referred. The age from 3 to 12 covers a span of nine years, yet many fillings are placed at the age of 3 or 4 with the idea of a temporary filling in mind. Would it not be a much better policy to place permanent fillings in deciduous teeth rather than temporary fillings? A wave of enthusiasm for this work is now sweeping the world, so let us all get back of this movement and keep dentistry for children on the crest of the wave where it rightfully belongs.

DEVELOPMENT OF NORMAL DENTITION AND ITS MAJOR DISTURBANCES AS A FACTOR IN MALFORMATION OF THE ARCHES AND IRREGULARITIES OF THE TEETH*

By P. T. MEANEY, D.D.S., Portland, Oregon

IN order to recognize some of the causes of malformation of the dental arches and irregularities of teeth, due to a disturbance of dentition, it will be necessary first to make a résumé of normal dentition.

At birth, all of the teeth except the second and third molars have begun to develop, their tooth germs lying embedded in the cancellus substance of the maxilla and mandible. Each tooth is enclosed in a separate crypt, and, as the tooth germ develops, there is a growth force produced. This force and the growth of the tissue within the mouth, such as the tongue and other muscle attachments, exert pressure on the lingual surface of the bone. The muscles attached to their surfaces transmit force to the bone through the periosteum, and the functions of mastication, deglutition and respiration act on them.

All of these are mechanical stimuli, to which the connective-tissue cells respond. In the entire process of development, the growth is the result of all the forces to which the bones are subjected, perfectly distributed through the substance of the bone by the agency of normal occlusion. Any lack of harmony in these forces may allow the teeth to meet, when they erupt, outside the normal influence of their cusps, causing the beginning of malocclusion. Any malocclusion disturbs the balance in the distribution of forces and results in a disturbance of the development of bone, which progresses during the entire period of development. This must result in a lack of balance in the features which will be proportionate to the malocclusion.

The bones of the face must be viewed not as solid and rigid but as containing millions of active cells which are continually building and rebuilding their substance. It has been natural, because of their hardness, to think of bones as solid and unchanging.

The first unit of dentition, comprising the development and eruption of all the deciduous teeth, is completed by the third year. All of the roots of the deciduous teeth are fully calcified by about the third year. Permanent teeth calcifying during this period are first permanent molars, central and lateral incisors and cuspids. The calcification of the bicuspids and the second permanent molars begins between the third and sixth year. The calcification of the third molars begins in the third period, about the ninth year. The continued calcification of all the permanent teeth will

*Read before the Children's Dentistry Section at the Third Triennial Session of the Pacific Coast Dental Conference, Seattle, Wash., July 8, 1932.

necessitate a fourth period, from about the twelfth or thirteenth year to the eighteenth or twentieth year.

Any influence toward normal development of the deciduous teeth and those permanent teeth whose calcification begins before the third year should be entirely in the hands of the physician as far as he is able to control the situation. The dentist has absolutely no opportunity to influence dental development prior to that age. No doubt exists at this time as to the importance of prenatal and postnatal feeding of mother and child. Disturbed organic function may have a harmful effect on tooth development during this period. The general endocrine system, when functioning properly, keeps the body in physiologic equilibrium and exerts a marked influence in the regulation of metabolism. The impaired function of the endocrine system in children has a decided influence toward maldevelopment of the osseous and tooth structures and on the position of the teeth.

During the second period, which is from the third to the sixth year, there are a small percentage of children under a dentist's supervision. The child is entirely in the hands of the parent.

In the third period, approximately from the sixth to the twelfth year, the dentist is entirely responsible, and we therefore shall discuss this period more in detail. It is during this period, when the temporary denture is being replaced by a permanent one in which the individual teeth are larger and more powerful, that it behooves us to be more cautious and give more consideration to changes taking place. It is during this period that a large percentage of cases of malocclusion have their beginning, owing many times to improper procedure or lack of knowledge of the true facts surrounding the case. It is impossible to give proper advice during this period without a full-mouth roentgen-ray examination, which reveals, in many instances, that teeth are missing, that there are present supernumerary teeth, transposed teeth, deciduous teeth resorbing prematurely or too late, impacted teeth, usually cuspids, second bicuspids and second molars, and abcesses, caries, cysts, involved sinuses, etc, and there is no way to determine which case will present such a picture other than by systematically examining the mouths of these children by roentgenograms.

If premature extraction of the first teeth is absolutely necessary, a space retainer should be used to prevent closing of the space. If it is near the time for normal shedding of several deciduous molars, they should all be removed within a reasonable length of time in order to permit the normal eruption of the bicuspids. All carious deciduous teeth should be attended to as long as they are retained in the mouth. If, near the time of normal shedding, a deciduous tooth remains firm in its position and does not seem to be resorbing normally, the proper procedure is to remove that tooth provided the permanent tooth is in position. If this deciduous tooth remains in the mouth, the permanent successor will be forced to take an abnormal position if it erupts at all. The fact that all succedaneous teeth develop normally in a position lingually from the roots of the deciduous teeth is the reason that they erupt lingually when the deciduous root fails to resorb.

Whether supernumerary teeth should be removed depends entirely on the conditions surrounding them. They too will interfere with the permanent teeth taking their respective positions normally.

If deciduous teeth are abcessed and they remain so and are still held in position, normal resorption does not take place and the permanent tooth will be deviated from its normal course of eruption. If it is possible to clear up this area, normal resorption will take place again after the infection has been eliminated.

Rickets is one cause of premature resorption of deciduous teeth and late eruption of permanent teeth, which allow the closing of spaces and produce serious maldevelopment of the bone. If there is premature loss of many deciduous teeth, the supporting osseous tissue of these teeth is also lost.

Tuberculosis is one of the main causes of early eruption and delayed normal resorption of the deciduous teeth.

It is during the third period that the eruption of the four first permanent molars and the eight incisors takes place. The four first permanent molars determine the relation of the maxilla and mandible during replacement. The relation of these teeth to each other determines not only the relation of all the other teeth to each other, but also the distribution of functional forces so as to mold the form of the face normally or abnormally. Early loss of the first permanent molars will cause a serious maldevelopment of the dental arches.

During the fourth period, from the twelfth to the twentieth year, we have the continued calcification of all the permanent teeth with the exception of possibly the lateral and central incisors and first molars, which should be completely calcified by the end of the third period. The eruption of the cuspids and the continued development and eruption of the third molars are our major problem during this period. Serious cases of irregularities of the teeth have been produced where there was not sufficient room for the eruption of the third molars. I do not advise extraction in young patients except in those cases in which close observation determines this to be the best course.

The relation of the bones of the jaws to the teeth is entirely secondary and transient. The bone grows up around the roots of the teeth to support them and is destroyed and eliminated by the loss of the teeth or cessation of their function. A new alveolar process grows up around the roots of the permanent teeth as they are formed. This development of bone leads to a change in the shape of the body of the lower jaw, increasing the thickness from the mental foramina to the alveolar dental canal upward. There is also a general development taking place in the maxilla and mandible. In the maxilla, the growth is downward, forward and outward. In the mandible, the growth is upward, forward and outward. When the permanent teeth are finally lost, this bone is again eliminated and the body of the jaw is reduced in thickness from above downward. This phenomenon has an important bearing on the causes and the treatment of disease conditions of the teeth, particularly those which involve the supporting tissue. From a dental standpoint, it is important to note that the teeth are formed first and the bone is developed to support them. The proper use of the teeth through occlusion reacts on the formation of bone. The study of anatomy, as well as direct experience, has shown that this muscular function, acting through occlusion, affects the development not only of the bone of the alveolar process of the jaws and face, but also of the entire skull. From this, we must realize that the teeth are moving with reference to the skull as a whole throughout the entire period of develop-

ment, in fact throughout life. Premature loss of a deciduous tooth or the extraction of a permanent tooth during the time of development will cause maldevelopment of the bone. Malocclusion is always a perversion of the normal dentition. Habits such as mouth-breathing, bad sleeping postures, thumb-sucking and lip-sucking also play a part in producing many of these perversions and their early correction will be an aid in the prevention of malformation of the arches.

The human denture requires the full period of physical growth and vigor to attain its complete development and perfection. We cannot expect to find a perfect denture in a frame every part of which has in development fallen short of its hereditary possibilities or pattern. The human denture not only requires full physical growth for its development, but also is itself a developmental mechanism by which the functional forces are distributed, the development of other parts, especially the framework of the head, resulting. The manner in which the denture is used becomes a characteristic of the individual.

Living tissues are characterized by relation and, in order to have a full development of the human denture, the living units of the tissues, the cells, must be of full vigor. They must be supplied by their food with all the elements necessary for their metabolism, and they must be stimulated to activity by the mechanical stresses brought to them by the full, vigorous functions in which the jaws and the teeth play a part.

CONCLUSION

Let me again stress the following:

1. The attending physician's responsibility to the mother and later to the child in assuring as nearly perfect development of the dental apparatus as is practical under the circumstances.

2. The responsibility of both the dental and the medical profession in disseminating general information to the public, in order to continue the groundwork which has been started by the physician, until such time as the patient comes under the dentist's care.

3. The effect of the care and retention of the deciduous teeth on the general facial development and the value of this dentition as an organ of mastication.

4. The importance of examining every case by the roentgen rays, as a means of prevention.

5. The value of thorough knowledge of conditions underlying the eruption and calcification of both deciduous and permanent teeth.

6. The importance of the time of resorption of the deciduous teeth and need for consideration of all of the complications which accompany the change from a temporary to a permanent denture.

7. The importance of early recognition of mouth-breathing, faulty sleeping postures, lip habits, etc.

8. The importance of preservation of the first permanent molars and the reaction and complications produced by the development and eruption of the third molars.

A MENSTRUAL VAGARY: REPORT OF CASE

By TRIM HOUSTON, D.D.S., Corsicana, Texas

A WOMAN, aged 24, whose menstrual flow has never been satisfactorily established, was annoyed by an erupting lower third molar, tipped buccodistally. Each month, there was discomfort, beginning a day or so before the flow, and lessening as it became free. The more difficult the menstruation, the greater the congestion and discomfort.

After some months of palliative treatment, the patient was advised to have the tooth extracted a week after the cessation of the flow. Misunderstanding or disregarding instructions, she came in one week before instead of one week after, as was discovered.

On the fifth day after the removal of the tooth, there appeared a slow, continuous hemorrhage from the socket. A pack stopped the flow into the mouth, but the blood escaped into the cheek tissue. The pack in the socket was removed. The cheek returned to its normal contour, gradually, as the blood flowed into the mouth. Within forty-eight hours, the menstrual flow was free and the hemorrhage from the socket ceased of its own accord.

The following month there was a very slight discharge. Since then (for four months), there has been discomfort and congestion, which becomes less noticeable each time.

Evidently, a case of vicarious menstruation.

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Editorials

BURDENS AND STILL GREATER BURDENS

The appalling burdens that are being heaped on our citizens by the mounting costs of government are developing into a serious menace, and unless something is done to curb the tendency toward governmental extravagance, the time will soon arrive when the producing part of our population cannot earn money enough to pay the taxes that are levied for the support of a lot of hangers-on who are not producing anything.

For the honest government employe who is working faithfully for the best interests of the country, we have the greatest respect. The government needs men of this caliber to safeguard the welfare of its citizens, but there has rapidly been growing up an ever-increasing army of office-holders who are not serving the government in any useful way, but who are using their energy in getting more and more out of the people without a commensurate return in the way of service. We do not wish to reflect on the ability

of the average government employe, but if every one of those connected with the government was doing his whole duty, we would not be presented with the spectacle of a percentage of one in every eleven of those gainfully employed being on the public payroll, when, a few years ago, it was only one in every twenty-two. At this present rate, it is said that, in a little more than twenty years, we shall have one person on the public payroll for every individual paying taxes.

The situation is becoming sufficiently alarming to enlist the active interest of every thinking citizen of this country, and it is not by any means too early to exert pressure to curb the prevalent tendencies of the day in this respect. The growing meddlesomeness of the government in matters that can better be managed by individuals is becoming notorious, and it is working like a two edged sword over the heads of the people. It is not only that gross extravagances are apparent but also that, in the very nature of things, there are many enterprises of life that cannot function properly under government control.

One of these is the direction of professional service under the so-called panel system or, in a slightly different relationship, under the higher sounding phrase compulsory health insurance. This matter has recently been brought more vividly into the limelight by the report of the Committee on the Costs of Medical Care, to which attention was called in our January issue, and since publication of that report, there has been a very strong reaction against this idea, not only in the professional press but also in various lay publications.

We are not in any way impugning the motives of this committee, but we are unable to see eye to eye with certain of the findings presented in the report. Carried to its ultimate conclusion, the trend of this report is in the direction of placing greater and greater power in the hands of the government, and less and less in the hands of the professions. As if the theories of the politicians as to how medical or dental practice should be conducted or directed outweighed the consensus of opinion of the best brains among professional men. Any control of the government or any influence

on the part of government directing the destinies of professional practice would at once be disastrous.

Take the experience of those countries where the panel system has been in operation and note the result. It is not only that the professions have suffered economically, but also that the character of service has greatly deteriorated. How could it be otherwise when the compensation established by the government has been so notoriously inadequate?

And even granted for the sake of argument that such a system might be practical in some countries, this is no indication that it would ever work in America. Traditions, tendencies and experience are all against it. The only reason that it has ever received any consideration whatever in this country is the severe economic stress under which our citizens have labored in the past few years, a stress that has strained the fiber of the people almost to the breaking point and naturally made them receptive to any idea that seemed to hold out the slightest hope of remedy.

No matter how fallacious any plan or idea may be, if it only carries with it the rainbow of a promised deliverance; it is eagerly seized on by people who are laboring under the difficult economic conditions of the day, and there is little wonder that some of our professional men have been inclined to lend a sympathetic ear to the siren song of state control. But when subjected to the alembic of a critical analysis, it will be found that the song is only that of a siren, and the rainbow is wholly devoid of gold at its end.

What this nation needs is less government rather than more government, less extravagance and chiseling in our governmental activities and greater economy, less padding of the public payrolls, and fewer employes, less puttering legislation and a saner approach toward every legislative problem; in short, more conscience and less political connivance, and an altogether greater regard for public and private welfare.

When a political body of the supposedly exalted character of the United States Senate costs the taxpayers the huge sum of $4,116,455 for maintenance during one fiscal year, and when the single item of senatorial mileage, drawn regardless of the actual

fare paid, sets the taxpayers back $46,329—well, comment seems unnecessary. Except that we might intimate that men of this caliber could not well be trusted to direct the activities of medical and dental service for the people of this country.

A BRIEF CONSIDERATION OF THE REPORT ON MEDICAL EDUCATION, 1925-1932

The Commission on Medical Education issued a very comprehensive report of 560 pages in December, 1932.

The chief recommendations as to dentistry, which may be found on pages 216-217, have been very succinctly summarized by Dr. William J. Gies, who wrote the Carnegie Foundation's Bulletin on Dental Education. Dr. Gies has set forth the commission's views as follows:

1. Dentistry should not be converted into a specialty of medical practice.

a. Dentistry should not be made a *graduate specialty of medical practice, such as surgery.* (Dental education should not be based on the M. D. degree.)

b. Dentistry could not be made a specialty of medical practice by *basing it on the first two years of the M. D. curriculum.*

(These recommendations accord with prevailing opinion.)

2. Dentistry should be continued as a separately organized profession.

a. Dental education should be as *"high in quality"* as medical education, but should be different and *adapted to the needs of the dental practitioner.*

b. Dental education should lead to a *distinctive degree and licensure.*

(These recommendations seem to refer to improvement of dental education, and continuance of the D.D.S. degree and of independent licensure.)

3. Dentistry should be developed *under* medical education (medical faculties), and made, like nursing, a profession *subordinate* to (and *controlled* by) the medical profession.

If the dental profession were subordinated and controlled as proposed, is it likely that the medical faculties would bring about the cleavage of dentistry into two parts—(a) a preferred portion, including oral surgery, to be called "stomatology" and converted into medical practice, and (b) the rest, to be continued as "dentistry" on a plane of education selected by the medical faculties?

How the dental profession would be brought under subordination and control is not directly stated in the report. Apparently "the universities" would be expected to accomplish the change. It does not seem probable that such a change could be brought about *unless and until the dental profession desires it.*

The report does not refer to the recommendation in the Carnegie Foundation's Bulletin on Dental Education that dentistry be made the health-service *equivalent* of an oral specialty of medical practice. Shall dentistry's working ideal—*inde-*

pendence with interdependence—be destroyed? The public interest requires coordination without subordination.

In answer to which we may affirm that this independence shall not be destroyed. We want the very closest cooperation between medicine and dentistry, to which consummation the better element of both professions are cordially lending their influence, but we assuredly will not give our sanction to the idea of developing dentistry "under" medical education. It has been an almost uniform experience that where the attempt has been made to teach dentistry under the auspices of a medical school or control has been directed by a medical faculty, conspicuous failure has resulted.

It is almost one hundred years too late to foster such an idea as this. The die was cast when, in 1839-1840, a medical faculty declined to admit the study of dentistry as a distinct department on the ground that it was not of sufficient importance to warrant such recognition. We are far removed today from any resentment because of this rebuff, for two reasons: first, the lapse of time has long since mellowed any possible irritation that might have been manifest a century ago, and, second, the result of the rebuff was to develop the study of dentistry in a way that never would have been possible under the auspices of medical educators alone. The independence of dental education has been its saving grace; a truism that is frankly acknowledged today by our best medical educators—in fact, by every one except a few, a very few, visionary and unbalanced apostles of a wild theory that has neither logic nor an appeal to the saner impulses of our common humanity.

This Report of the Commission on Medical Education is worthy of careful study. A cursory glance would seem to indicate that, for the most part, it is constructive in character and a distinct contribution to a subject that must be accounted of the utmost importance to professional well being.

DON'T TELL ANYTHING

Mark Twain is said to have remarked: "When in doubt, teli the truth," but a better maxim would be "When in doubt, don't

tell anything." This holds particularly true when the telling of a thing is likely to get some one in trouble. Members of the profession are altogether too prone to make thoughtless and disparaging remarks to patients whenever there chances to be a dispute about bills or about the quality of work. Much of the serious controversy between patients and practitioners is brought about by the meddlesome remarks of other dentists, and the harm that is thereby done is incalculable.

A patient receives a bill from a practitioner for professional services, and, as is occasionally the case, there is a complaint about the fee charged. Almost invariably, the patient feeling aggrieved consults another dentist, and it is at this point that much harm is unwittingly or wittingly done. It is little short of poisonous for the dentist thus consulted to pour into the patient's mind the idea that the first dentist has treated the patient unfairly. This may be done merely by innuendo or by direct criticism, and the former is fully as deadly as the latter, sometimes more so. For the dentist thus consulted to fan the fires of resentment on the part of the patient by a subtle shrug of the shoulders, or by an uplifted eyebrow, is fully as reprehensible as to deliberately seek out any possible or suspected vulnerability in the mechanism of an operation and pass open judgment on it. Either one of these procedures constitutes itself a downright wrong, and it invariably leads to further contention, and frequently to unfortunate litigation when the temper of the parties has been raised to the point of bringing the matter into court.

In the first place, there is no possible way whereby the dentist consulted can form a just estimate as to the extent of the service rendered without at least having full clinical records of the case as a basis on which to judge the character of the various procedures and the time consumed. Even with all of this, there is no way of estimating the peculiar difficulties that are often encountered in carrying out a piece of work, the nervousness of the patient, the unusual technical complications that must frequently be overcome and the various handicaps that often accompany professional service. No one can actually know except

the man who does the work just what is involved in a series of operations, and for a third party to pass judgment on it is not merely presumptuous in the extreme but may be downright venal.

One of the fundamental functions of life is to further the harmony and peace of mind of all of those individuals who are brought in contact one with another in the various relationships of our so-called modern civilization, and the growing complexities of this civilization are such that there is sore need of every possible bit of consideration and forbearance in our intercourse with our fellowman. To stir up needless strife among men comes very near to being one of the major crimes, and this is particularly true of professional men, whose ethical traditions are supposed to be a trifle more exalted than are those of men in barter and trade. A dentist should never stoop to so belittle himself as to deliberately stir up trouble between a patient and a fellow practitioner. Rather should he do his utmost to harmonize the different points of view and bring about a better understanding. Most of the contention in life is caused by misunderstanding, and one of the sweetest services that can be allotted to a man is to be able to effect a reconciliation where two individuals have reached an *impasse* over a difference of opinion.

Why then do men foolishly or thoughtlessly widen the breach by disparaging inferences or implications which can do no good to anyone, but must inevitably work injury to all? The futile desire to curry favor with the patient by reflections on the previous dentist is so silly and transparent that it invariably acts as a boomerang. Most of the suits for damages against dentists have their genesis in idle or vicious comment to the patient on the part of other dentists; most of the threats to bring suit would fall flat if not fanned into flame by unworthy implication. The sin of this kind of meddlesomeness is unpardonable when judged by the measure of the harm and unhappiness that it inevitably engenders.

Think how much misery might be averted if the dentist who is consulted under such circumstances would only assume an attitude of conciliation and kindness in the presence of the patient. There are usually two sides to all questions, and the really big man is

the one who can look unswervingly on both sides. An angry patient is disarmed at once by an attitude of honesty and frankness and forbearance, and many a patient has been mollified by the kindly offices of a practitioner whose heart is in the right place. "Blessed are the peacemakers for they shall inherit the earth," is as applicable today as in the days of old. In very truth, the need for peacemakers is even more insistent now than ever, and this is particularly true in our professional relationships. People today, under the stress of recent economic maladjustments, are more sensitive in every way to what they deem an economic injustice than in ordinary times. Let us recognize this and let us accordingly be big hearted, broad minded and charitable in our attitude toward everyone—to our patients and to our fellow practitioners as well.

All of this is, of course, entirely aside from the question of a rank and manifest injustice to the patient on the part of a dentist. The first rule of professional life should be to protect the patient against imposition of all kinds, and to seek to remedy a wrong of whatever character. In doing this, the professional man should have a care that he does not add to the difficulties of the situation by reflecting on the previous operator and inciting malice. His function is to remedy the wrong as best he may, and not indulge in personal recrimination. It never does any good, and frequently does much harm.

When an injury has resulted to a patient from the carelessness or neglect or blunder of a dentist, little good can come from idle comment, and usually the less said the better. It is a good rule to reiterate: In case of uncertainty, don't tell anything.

Giving people the benefit of the doubt is a great moral principle, and if carried out in professional life, it would do much toward alleviating contention and bringing about the millennium of harmony and happiness.

WHAT NEXT?

Apparently without due deliberation, an order has been passed by the U. S. Navy that will never be sanctioned by the dental profession of this country. The information comes from the *Dental Outlook* of January, 1933, and is as follows:

THE RECOGNITION OF AMERICAN DENTISTRY AS A STOMATOLOGIC SPECIALTY OF MEDICINE

At the meeting of the Oral Surgery Section of the Second District Dental Society of the State of New York, *a component of the American Dental Association, official representative of organized dentistry in the United States,* held on Thursday evening, Nov. 17, 1932, at the U. S. Naval Hospital, Brooklyn, N. Y., Captain Charles S. Butler, M.D., U. S. Navy, Commanding Officer, U. S. Naval Hospital, New York, in his address of welcome, gave a brief résumé of the history of dentistry as a branch of the medical profession from its earliest days up to the present time. He concluded his remarks by announcing the recognition of American dentistry by virtue of its expansion. He informed those present of the change in the designation of the dental service of the U. S. Naval Hospital in Brooklyn to embrace its broader aspects which will henceforth be called the *Stomatologic Service* in accordance with the following order:

U. S. Naval Hospital
New York City
16 November, 1932.

Hospital Order No. 100

Subject: Dental Service, Change In Designation Of.

1. With the *approval* of the Surgeon General of the United States Navy and effective November 17, 1932 the title 'Dental Service' heretofore employed in designating the Dental Department will be changed to the 'Stomatological Service' and the Chief of that service will be designated as the 'Chief of the Stomatological Service.'

2. The term 'Dental Service' where it may appear in Organization tables, Hospital Orders, Hospital Memoranda and otherwise, will be changed accordingly.

C. S. Butler
Captain (M. C.), U. S. Navy
Commanding.

It seems pertinent to suggest that this apparently off-hand provision calls for a few queries. Is it possible that the distinguished and level-headed Surgeon General of the Navy deliberated on this order with sufficient care? The order states that this change was made "with the approval of the Surgeon General," but we cannot help wondering how far the Surgeon General went into the question before he gave his approval.

The order is so contrary to the general sentiment of the dental profession, and so subversive of its best interests and the interests of the Navy, that it must cause amazement to the thinking men of dentistry. It is against tradition, against common usage and against the deeper feelings of the entire profession. We cannot but conjecture that the order was passed without due consideration and without knowledge of the consensus of opinion of organized dentistry, and we trust that we may not be considered presumptuous in suggesting that the order be rescinded at the earliest moment. Its prompt abrogation will work for the best interest of all.

100%

There is supposed to be a depression and maybe there actually is; but depressions do not mean much to some people. When the Christmas Seals were sent out, Dr. Celia Rich of Nashville, Tenn., wrote the Editor asking if recognition of the fact would be made in THE JOURNAL in the event that any district society contributed one hundred per cent. It is not difficult to surmise what the answer was. Accordingly, we are announcing that the First District Dental Society of Tennessee has turned the trick. There are twenty-two members, and the president, Dr. E. C. Lunsford, of Greeneville, just before Christmas forwarded a check for $22. Hats off to the First District!

It is quite likely that there are other societies that have contributed 100 per cent, and we feel that recognition should be made of this fact. To every society that has contributed the full quota to the seals, we will make acknowledgment in THE JOURNAL on notification from the proper officers.

Still another: On December 23 last, Dr. Ralph E. Bishop, of Fox Chase, Pa., wrote that, on the occasion of the recent meeting of the North Philadelphia Association of Dental Surgeons, the president, Dr. Elmer E. Henry, urged the members to buy Relief Seals, and instituted the idea of decorating a cracker can with Christmas Seals and punching a hole through the top for the members to anonymously contribute in addition to their regular sup-

port of the seals. The sum of thirty dollars was thus collected and forwarded to the Chairman of the Dental Relief Fund Committee.

Such occurrences as those just noted tend not only to materially augment the fund, but, of equal moment, also broaden the sympathies of our members and warm the hearts of the contributors, making of every one of us nobler and better men.

Later: Since the foregoing was written, we are informed that Raleigh, N. C., has made a one hundred per cent contribution—eighteen members, eighteen dollars.

In another connection relative to relief, we have a most fortunate circumstance to relate. Several years ago, one of our late members of Houston, Texas, received a contribution from the A. D. A. relief fund, and owing to various acts of kindness to this member by Drs. W. H. Scherer and J. P. Arnold, the latter two gentlemen were made beneficiaries of a small insurance policy at his death. On receipt of an annual return from this policy, the beneficiaries felt that they would like to turn over the proceeds for the benefit of the relief fund, and accordingly they transmitted a check to Dr. Olin Kirkland of the Relief Committee and Relief Commission, which has been duly received and acknowledged.

Thus the good work goes on and it seems a very appropriate and logical example for others to follow under similar circumstances.

A LETTER OF THE LATE CALVIN COOLIDGE

We are indebted to Dr. John F. Stephan, of Cleveland, Ohio, for permission to reproduce, from his private scrapbook, a letter of the late Calvin Coolidge, addressed to Dr. Stephan shortly before the annual meeting of the American Dental Association in Cleveland in 1923. President Harding, a patient of Dr. Stephan, had been invited to address the Association, and after his death, the invitation was extended to President Coolidge. His reply, reproduced on the following page, was read before a general meeting of the Session.

THE WHITE HOUSE
WASHINGTON

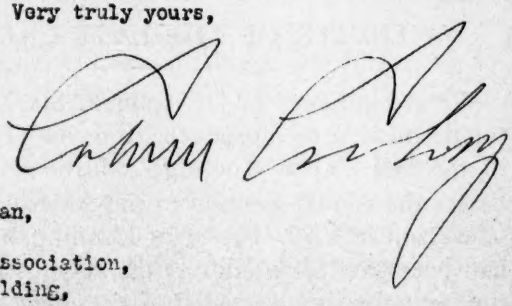
September 6, 1923.

My dear Doctor Stephan:

Your very cordial invitation to the Annual Convention of the American Dental Association has been received. It would, of course, give me a great deal of satisfaction if I could consider it favorably. I should like to be present on account of the great importance and the high degree of skill which your profession represents. You contribute, not only to improving the appearance, but even in a more marked way to improving the health of the people. It is but recently that governments have begun to give scientific attention to public health. Our own Army and Navy have recognized the importance of your profession by provision for it within their medical staffs. You are raising up the efficiency and the morale of the American nation, in that respect being more than private practitioners of your profession, and rising into the place and dignity of public benefactors.

Wishing you every success in the intelligent effort which you are making to rise to these high standards, I am

Very truly yours,



Dr. John F. Stephan,
Vice President,
American Dental Association,
1122 Guardian Building,
Cleveland, Ohio.

COUNCIL ON DENTAL THERAPEUTICS

DENTAL PRODUCTS AND THE FEDERAL FOOD AND DRUGS ACT*

By F. J. Cullen,† Ph.G., M.D., and H. Wales,‡ Ph.D., Washington, D. C.

The Federal Food and Drug Administration has, for the past few years, given special regulatory and analytic attention to several classes of products which are of interest to dentists.

Limited funds and personnel make it necessary for the Administration to select for first consideration those products which are of greatest importance from a public health standpoint. As these are brought into harmony with the requirements of the law, the project will be extended to cover the other important products.

Before we discuss the activities of the Food and Drug Administration in connection with dental products, it may be of interest to you to learn in brief what protection to the public Congress contemplated in enacting the Federal Food and Drugs Act, commonly referred to as the Pure Food and Drug Law. Many people have the erroneous idea that its only function is to insure the purity of foods and drugs. The law as originally passed, June 30, 1906, stated in substance that packages of foods and drugs shall not bear statements, designs or devices that are false and misleading as to the ingredients contained. Therefore, the product must be of a recognized standard of quality, purity and strength; and such standard may be that set up by recognized authorities such as the United States Pharmacopeia or National Formulary, or by the product's own label. In 1912, the Sherley Amendment was added to the law. This amendment states in substance that a drug package or label shall not bear or contain statements relative to its therapeutic value which are false and fraudulent. The courts have held that the labeling includes any printed matter which accompanies the package in interstate commerce. You will observe that, under the terms of the Sherley Amendment, we must prove not only that the product is falsely labeled but also that the deceiving therapeutic statements are made knowingly, in wanton and reckless disregard of the truth, and are, therefore, fraudulent. Products are subject to the Federal law only if they are shipped in interstate, import, or export commerce or are offered for sale in the District of Columbia or a territorial possession of the United States.

*This article was deemed of sufficient importance by the editorial staff to have it used in lieu of the customary council report for this month.—Editor.

†Chief and ‡chemist, respectively, of the Drug Control Unit, Food and Drug Administration, U. S. Department of Agriculture, Washington, D. C.

During 1926, a preliminary survey was made of a few products labeled as antiseptics. It was at once evident, from the number of worthless products found on the market, that conditions in this field justified a thorough investigation. The first problem was to determine what constituted an antiseptic under the conditions of use. It is obvious that if a product is to be of any value as an antiseptic, it must be effective against the pathogenic micro-organisms with which it comes in contact when used as directed. Therefore, we must look to the labeling of each product to determine the meaning of the term "antiseptic" as it applies to that article. If the product is to be used as a lotion, salve or wet dressing, and would be in contact with the body for a long period of time, it can be said to be antiseptic if it has the power to inhibit the growth of pathogenic micro-organisms. But if it is in contact with the body for only a short time, as are mouth washes, gargles, douches and similar preparations, the product should be germicidal, i.e., should have the power to kill pathogenic micro-organisms, before it can be considered antiseptic. One should remember that these products have an effect only on the germs with which they come in direct contact. There are many germs buried in the crypts, folds and deeper tissues of the body that are not touched by the preparation. These organisms are not affected and are therefore responsible for any ill effect which may result from the germ infection.

The results of our initial survey were startling. Many antiseptics were found to be recommended for use in dilutions far beyond those in which the products could have any antiseptic power. Two of the so-called antiseptic mouth washes examined during that period were found to contain living bacteria. Fortunately, these were not of pathogenic types. Not only were a large number of these products found to be lacking in antiseptic properties, but their labels also offered them for the prevention and treatment of nearly every known disease. Mouth washes and, to a lesser extent, tooth powders and pastes were found to be labeled as for use in treatment of pyorrhea, gingivitis or disease conditions of the mouth and gums in general, when, as a matter of fact, the action of antiseptics in the mouth is primarily that of a cleanser, although in addition they may be astringents or alkalinizers, or be capable of destroying free bacteria in the saliva.

Following is an example of the labeling of a typical mouth wash before (left) and after (right) consideration by the Administration.

An Active Astringent, Antiseptic and Deodorant Makes the Gums Firm and Healthy The Breath Pure and Sweet and Tones the Entire Oral Cavity For Pyorrhea Tender, Spongy Bleeding or Receding Gums or any Unhealthy Condition of the Oral Cavity	An Active Astringent and Deodorant Is Eminently Beneficial Is Astringent and Aromatic Sweetens the Breath and For Use as a Wash Spray Gargle Application or Douche

Another product, which was found to be a hydro-alcoholic glycerine solution of aluminum chloride with small quantities of essential oils, was labeled as "A delightful, refreshing and purifying Mouth Wash—Healing, Antiseptic and Prophylactic. Keeps the Gums firm—Preventative treatment when Pyorrhea is threatened." Since the phrase "A delightfully refreshing mouth wash" constituted practically the only portion of the label which could be justified, the manufacturer decided to withdraw the product from the market.

In the enforcement of the Federal Food and Drugs Act, the courts have held that the language used in the label should carry the meaning ordinarily conveyed by it to those to whom it is addressed. One who is seeking something that will rid him of his trouble is more concerned with the names of the affections for which the product is recommended than with the language employed. It is immaterial whether the product is labeled as a "cure," "remedy," or "relief" or as "useful in the treatment of," "indicated for," or simply "for" certain affections. The question is whether or not the product in itself, by reason of the contained ingredients, constitutes an adequate treatment for the disorders named.

Many manufacturers, in the literature relating to their product, will copy portions of statements from various medical and dental textbooks. Statements in such books are made for men who are trained in their field of work and are capable of interpreting these statements. Often, if the whole statement were copied, it would put a different light on the matter, even in the mind of a layman.

After careful consideration of the labeling, the Administration may decide that the shipment was made in violation of the law and institute regulatory action. This is a matter which must be finally decided by the courts on the basis of the evidence submitted. In order to prove that any therapeutic claim is false, it is necessary that specialists in a particular line of work shall agree as to what does or does not constitute a treatment. Obviously, no action can be brought against any product when there is an honest difference of opinion between reputable specialists within that particular branch of a profession. In cases instituted against products offered for use in the mouth, we turn to the dental profession for aid. We depend on a consensus of dental opinion to determine what action is indicated.

In discussing therapeutic label claims with various manufacturers, we often find that statements have been obtained from dentists which, when interpreted literally by a layman, would convey the idea that the product was for use in treatment of such serious disorders of the mouth as, for example, pyorrhea. When the value of the product is discussed with a dentist, he usually states that the product in and of itself is not a cure for such a disease, but that cleaning the tartar from the teeth and numerous other procedures are necessary. He will say that the real significance of his statement would be apparent only to the dentist who is capable of judging the type of treatment to be used for the underlying disease condition. The manufacturer is using the statement of the dentist on the label of a product sold to the layman seeking a remedy for the disease. The layman sees a statement on the label of a product reading, "I have used Smith's Preparation with great success in the treatment of mouth diseases, signed Dr....., D.D.S.," and is naturally led to believe that this product will benefit him. Only too often the result is a lack of proper treatment at the time when it would

be of most benefit and the establishment of a systemic disease, or at least an irreparable damage to the teeth.

The usual meaning of the word "prophylactic" is anything that prevents, or that contributes to the prevention of disease, a preventive.[1] We gather from reliable sources that, in dental parlance, the word means little more than "cleansing." If a product is labeled "prophylactic—for use on cuts and in the mouth," are we to interpret this to mean that, when applied to a cut, the article will protect against infection, and when used in the mouth, it will merely clean? A mouth wash cannot be prophylactic in the protective sense, as understood by the average layman, since it cannot reach the points at which mouth and throat infections start. Manufacturers insist on referring to both tooth pastes and mouth washes as being prophylactic. Unfortunately, the dental profession and the public do not exactly agree on the meaning of the word "prophylactic." The word has a far different meaning to the laity from what it has to dentists.

Another type of statement is often made both by dentists and by physicians. They frequently declare that they have used a certain product in their practice and have found it to be antiseptic. The fact that such statements have no scientific basis carries little or no weight with a jury of laymen who believe that the physician and dentist are in a position to know that the product is antiseptic through the actual use of it. From our careful study of the situation, we are positive that only tests made on bacteria by trained bacteriologists will show whether a product is antiseptic.

These are just a few of the problems encountered in the enforcement of the Federal Food and Drugs Act. To maintain successfully, in court, a case involving a dental preparation, the Administration must depend on a consensus of dental opinion. If there is an honest difference of opinion between reputable dentists, the case is lost. From our investigations, it seems to be the consensus of opinion among dentists that the various mouth diseases cannot be adequately treated with mouth washes and tooth pastes, but members of the dental profession making unqualified statements such as those quoted above cannot fail to create some doubt in the minds of a jury as to the existence of such an agreement in opinion.

We wish to mention a class of products which are sold only to the various professions and which bear claims for the treatment of serious or incurable diseases. The dentist or physician is rarely given more than a faint idea regarding the composition of the product. He is flooded with excerpts from scientific literature which apparently show that the product has been found, usually by some foreign person, to be a wonderful treatment for the diseases mentioned. Being a busy man, he may accept these statements at face value and use the product in connection with a well-established treatment which, he knows from experience, will produce the required results, so that he is not quite sure which preparation, or which of the treatments used, was responsible for the results. Yet, too often, he makes rather loose statements as to the value of the product, and these are always exaggerated by the manufacturer. Editors of medical and dental journals have been outspoken in their denunciation of worthless dentifrices and other medical products as well as of testimonials which are unsupported by

1. Patterson: Am. J. Pub. Health, 32:465,1932.

facts. Even when certain of the preparations that we have spoken of have been shown to be composed of well-known drug ingredients, it would, we believe, be virtually impossible to find a dentist or physician who would state that he was misled by claims appearing on the labels or in collateral advertising, in newspapers or broadcast by radio. Physicians and dentists get their ideas of the value of certain proprietary products largely from advertising matter sent by mail. The average lay buyer obtains his knowledge of the value of tooth pastes, mouth washes and similar articles, from newspaper advertising and radio broadcasts. Both types of advertising generally are highly extravagant, but both are beyond the regulatory control of the Federal Food and Drugs Act.

CURRENT LITERATURE

EXTRACTS AND ABSTRACTS

Report of the Committee on the Costs of Medical Care: The physicians of this country are the only group with the knowledge, training and experience necessary to practice medicine. Intent on their daily and nightly task of preventing disease, healing the sick and ministering to the afflicted, they have given scant attention and but little of their time to a consideration of the way in which their work was being invaded by the octopus of big business. They have been little disturbed by the extraordinary schemes for reorganizing their methods of practice proposed by philanthropists, sociologists, socialists and overambitious public health officials. Now the time has come when they can no longer overlook the problems created by this invasion. Public health officials are beginning to see the necessity of giving medicine back to the doctors. Let those who would, without medical training, change the nature of medical practice realize that medicine is peculiarly the doctor's problem. There can be no practice of medicine without doctors. These invaders will find that there are few physicians indeed so unaware of their obligation to medicine as a profession that they are ready, even in such times as these, to sell their medical birthrights for the promoters' mess of pottage. There is, moreover, a far greater concern than the rights of the physician to practice as his knowledge and training indicate is desirable. There is the question of Americanism versus sovietism for the American people. There is the question of the right of the American citizen to pick his own doctor and his own hospital, to pay his own bills with his own money, to be responsible to a doctor who is responsible to him. Let the big business men who would reorganize medical practice, the efficiency engineers who would make doctors the cogs of their governmental machines, give a little of their sixty horse power brains to a realization of the fact that Americans prefer to be human beings. The commissions, the committees, the five year studies and the special reports seem to be a product of the period of inflation when the world went mad over efficiency systems, organization and standardization. Perhaps the return of rationality associated with the period of deflation will cause this report on the care of sickness to be viewed in proper perspective. —Editorial, *J. A. M. A.*, Dec. 10, 1932.

Artificial Respiration: According to W. W. Babcock (*Am. J. Surg.*, August 1931), artificial respiration is not to be considered a gesture but an effect. The Silvester method, which involves moving the patient's arms violently up and down, preventing careful control of the jaws and tongue, accurate observation of the air movements and the use of intravenous injections, is condemned, together with the use of the pulmotor. For twenty years, the author has used the following routine: If cessation of respiration is feared or occurs, the anesthetist affixes a delicate wisp of cotton by a bit of adhesive plaster or collodion to the tip of the patient's nose, to serve as an indicator of spontaneous or induced air movements. The patient's arms are extended alongside his head. The operator standing on the right side facing the patient's head, clasps his hands together over the manubrium of the patient, his elbows and forearm coapting the lateral thoracic walls. With pressure of the hands, forearms and elbows back, down and in, aided to some degree by the weight of his body, which is swung upon the patient's chest, the operator produces expiration, at the same time watching the patient's face and noting the effect of his pressure upon the cotton indicator. The effect may be aided by pressure from the hands of an assistant which are placed under the operator's elbows. Inspiration, of course, results as the pressure is sharply released. The anesthetist maintains an open airway by keeping the mandible and tongue forward, notes the movements of the tidal air produced, watches the pupils and the carotid, temporal or radial pulse and is prepared to administer carbon dioxide oxygen or some other restorative. Nothing should be given by inhalation until the operator has proved that he can produce adequate movements of air to and from the patient's lungs.

Compression methods at times fail, i. e., in emphysema, when the chest is heavy and barrel-shaped, or there is a pleural effusion or disease of the lungs. The senile chest sometimes has limited compressibility, and the same may be true of that of a young child or an athletic young man. In these cases, forced inspiration by mouth to mouth insufflation is employed. In children, care must be taken lest too much pressure be produced. This method, the author regards as "foolproof," in contrast to oxygen-carbon dioxide therapy in these emergencies. He states that efforts at artificial respiration should be continued until the heart no longer responds, and even for many hours, and the patient must be kept warm.

Raw Milk as a Preventive of Dental Caries: In the Section of Odontology of the Royal Society of Medicine, Mr. E. C. Sprawson, lecturer on dental surgery, London Hospital, reported observations to show that raw milk influenced the calcification of the teeth and conferred immunity to caries. He supervised groups of children in institutions and was impressed by the high incidence of dental caries among them. The incidence was progressively less in the teeth, whether decidious or permanent, in the order of their eruption. He investigated the effect of a daily ration of raw milk begun during the first twelve months of life. As the deciduous dentition was not completed until the end of the second year, he excluded from the survey all the children thus fed, until they had reached the age of 2 years. The cases fulfilling this condition numbered only forty, but the results were remarkable. The average age at which the ration was begun was 4½ months, and when the children were observed at the age of 4 years, not a trace of caries was found. In thirty-three other children who were over 12 months when the ration was begun (in none not later than 2½ years), twenty-six at the age of 4½ years showed no caries and the remaining seven had fourteen carious teeth. He had thus had the remarkable experience of examining seventy children over 2 years of age of whom sixty-three were totally free from dental caries. Yet nearly all these children were subnormal on admission to the institution, suffering from gastro-intestinal disturbances and rickets. When the ration of raw milk was begun at later ages, an effect was still evident. In twenty-eight children, it was begun at the average age of 4 years and 8 months. The present ages of these children was from 7 to 10 years and 9 months. Though most of them had carious deciduous teeth, in only two was there caries of the permanent teeth. A further control was done at a still later age. Forty-four boys came on the ration before the end of the eleventh year and were now 13½ years of age. The second permanent molar was studied and eleven cavities were found in six boys. Raw milk appeared to confer incomplete immunity if begun at a time when it was no longer a physiologic food. Nearly all children got a milk ration during the first three or four years of life, but always sterilized by boiling or pasteurization. This destroyed or impaired the antiscorbutic vitamin. The effects of raw milk on the teeth indicated a longer period of breast feeding than usually practiced. For ideal dental development, he recommended a daily ration of raw milk until the age of 14.—London letter, *J. A. M. A.*

Agranulocytosis: It would appear from a clinical standpoint that sodium nucleotide rather than sodium nucleinate is the logical thing to use in these agranulocytosis cases; that the stimulation to leukocytosis that is given by x-ray, small doses over the bone marrow, is of doubtful value on account of the fact that it is preceded by leukopenia and is apt to lead to aplasia of the bone marrow; any sort of surgery on these cases, with the exception of blood transfusions, is a very hazardous thing to attempt; the most common symptoms complained of are loss of pep, loss of energy, a general feeling of being under par physically; one of the cases that had had antiluetic treatment and much arsenic showed a high degree—that may be a contributing factor. And the last conclusion that I have to offer, which will save you a great deal of chagrin, is the fact that a blood count should be made and a differential blood count on any case that presents an ulcerative lesion of the mouth or that is not getting on well. Differential counts are of extreme importance under any circumstances.—Austin A. Hayden, in *Illinois M. J.*, December, 1932.

Treatment of Trigeminal Neuralgia: It is now about twenty years since Harris' first papers on this subject were published (*Brit. M. J.*, July, 1932). In this interval his experience of many hundreds of cases has confirmed his view of the advantages which successful gasserian injection has over any open gasserian operation. In those cases of ganglion injection in which he has in-

jected the inner portion of the ganglion and left the third division with full sensation, should recurrence of the pain happen a further injection should be as easy as on the first occasion, as the sensory guide of the third division is unimpaired. He has frequently heard the statement repeated that, though the first alcohol injection may be satisfactory for a time, a second injection is of no use. This is quite untrue except when injections have been so frequent that a condition of fibrosis in the zygomatic fossa has been set up, which renders manipulation of the needle difficult; there is no possibility of the nerve becoming immune to alcohol. In such fibrotic cases it is particularly impossible to make injection satisfactorily, and the open root-section operation is then the only remedy. In a certain proportion of other cases it will no doubt be found impossible to obtain deep or total ganglion anesthesia, probably in over 80 per cent either by the route through the sigmoid notch or by the longer anterior route. Anesthesia that has persisted unaltered for a month after injection of the ganglion may be considered permanent and unlikely to diminish to any marked extent.—Abstr. *J. A. M. A.*

Vitamins, Rickets, Scurvy and Dental Caries: Food faddists may be a nuisance but drug faddists may be much worse, and the vitamin D faddists have given an impetus and opportunity to them to foist their potent drugs on the public such as they never had before. Those who are commercially interested have taken excellent advantage of this. We can hardly blame them, any more than we can blame the lovers of chemicals in pure or crystalline form, who boom sugar as an article of diet, particularly for children. Scientists were supposed to have proved its great value beyond doubt. The question of overdosage hardly entered their heads, yet harm can be done with an extremely small amount under certain circumstances . . . . If children are allowed to play in the open, and get their normal quota of daylight and sunshine, and are supplied with food which has not been deliberately "purified" for experimental purposes, are even strictly regulated therapeutic doses of vitamin D justifiable? Indeed, we may ask if it would not have been better if potent "vitamins" or hormones taken by the mouth had never been foisted on the community? On the other hand, if physiologists and biochemists had only recognized that the alimentary canal was provided with mucous glands and phagocytes to keep it in an hygienic state, and that certain principles in the food which stimulated the glands of oral and alimentary hygiene were required, what a vast amount of research for supposedly mysterious life-giving factors would have been saved. Surely, it should be recognized that the mouth and alimentary canal are or may be kept in a healthy state by physiological means, and that stimulating principles to this end are to be found in ample amounts in natural foods that supply the requisite nutrition. Finally, let me say that some day I hope the principles of biology will prevail and dreams of purified synthetic foods, supplemented by standardized amounts of an alphabet of vitamins or drugs, may give place to a rational diet based on scientific knowledge of *foods* and not therapeutic remedies. The desirable qualities based on these principles are easily understood by those, at least, who have taken an interest in the evolution of man and the correlated story of the *foods* which have served him in good stead for countless generations.—J. Sim Wallace, in *Pub. Health,* December, 1932.

Premedication with Barbiturates: Brown (*M. J. Australia,* Oct. 8, 1932) states that morphine injected in the usual dosage is quite inadequate to prevent the emotional disturbance in a patient attendant on being taken to the operating room, watching the preparations, and inhaling the fumes of an anesthetic until unconciousness supervenes, but that the barbiturates are capable of reducing fear and psychic shock. The amount and concentration of the anesthetic may be lessened by their use. Also the postoperative discomforts are decreased. The barbiturates prolong unconsciousness after operation, and this is followed by a further period during which the senses are dulled, although the patient is cooperative. Local and spinal anesthesia are assisted by the use of the barbiturates; the dose should be only sedative and not hypnotic, as otherwise the patient may become restless. A further advantage is that the toxicity of procaine hydrochloride and cocaine is lessened. The barbiturates should not be used as the sole anesthetic. The barbiturates should not be employed in patients who show signs of lung disease. When renal deficiency is present, the dosage of the barbiturates should be diminished. The author reviews twenty-four cases in which the barbiturates were used. —Abstr. *J. A. M. A.*

MISCELLANY

HOST CITY OF CENTENNIAL DENTAL CONGRESS A DENTAL CENTER

Chicago, host city for the Centennial Dental Congress, which includes the Diamond Jubilee of the American Dental Association, has valid claim to the title of "America's leading dental center." Out-of-town visitors to the Congress will have ample opportunity to convince themselves of this fact during the week of Aug. 7-12, 1933, when the Congress will be in session at the Stevens Hotel.

First of all, Chicago is the home of the American Dental Association. In May of 1931, the Association acquired its own home, located at 212 East Superior St. In it are housed all the central activities of the organization, such as the Secretary's office, Library Bureau, Bureau of Public Relations, Editorial offices, Bureau of Chemistry, Council on Dental Therapeutics and Subscription and Business Departments. The American Dental Association will hold "open house" during the week of the Congress in order that every visitor may see the Association at work with its own excellent facilities.

As many thousands of dentists throughout the world who received their dental education in Chicago well know, this city has three of the leading dental colleges of the country: Chicago College of Dental Surgery, Dental Department of Loyola University, the University of Illinois College of Dentistry and the Northwestern University Dental School. Their combined alumni form a very substantial portion of the world's dental population. To many, the week in Chicago during the Congress will be an unusually happy homecoming. Among the 15,000 dentists who are expected to attend the Congress will be many former classmates and friends of most practicing dentists. What an opportunity for a reunion!

Another claim of Chicago that merits mention is the fact that this city is annual host to the Midwinter Clinic of the Chicago Dental Society. Within the past decade, the reputation of this meeting has spread to every nook and corner of the country, so that it now occupies an enviable position among dental meetings. The Chicago Dental Society, sponsor of the Congress, is the largest local dental society in the world.

In Dentistry's Hall of Fame, we come upon the names of many Chicagoans who have helped make dental history: W. W. Allport, G. V. Black, Truman W. Brophy, Calvin S. Case, George H. Cushing, T. L. Gilmer, Hart J. Goslee, L. P. Haskell, Edmund Noyes, J. H. Prothero, C. P. Pruyn and many others that could be enumerated if space permitted. Certainly this is a roster of which Chicago and the whole civilized world may well be proud.

Yes, the host city for the Congress is a dental center. All the dental organizations and institutions in Chicago have been planning for months to make the Congress and the Diamond Jubilee of the American Dental Association the outstanding dental meeting of all time. Members of the Association are not only cordially invited, but also urged to attend this meeting which will be held in conjunction with A Century of Progress Exposition.

LEGISLATION AND CORRELATION

By HOMER C. BROWN, *D.D.S., F.A.C.D.,
Columbus, Ohio

The January issue of THE JOURNAL contained articles, editorials and other data, some under "Miscellany," with at least an indirect relation to legislation and correlation, and which should be read carefully by every member of the Association. In addition to this, the *Journal of the American Medical Association* has been publishing interesting dental data, especially those regarding court decisions. Further, the case pending in the Court of Appeals, Cuyahoga County, Ohio, has just been decided in favor of the board in a strong consistent opinion. It is my belief that more favorable court decisions have been rendered in the past few months, in upholding a favorable status for the practice of dentistry, than have ever been rendered in any one past decade.

*Chairman, Committee on Legislation and Correlation.

All of these decisions strongly emphasize that the principal duty of the boards is the protection of the health of the public, which is indeed one ray of hope in these days of great economic disturbance.

It is likewise encouraging that Dr. Dittmar and I, after three days in Washington in December, conferred, together with others, with Hugh S. Cumming, Surgeon General of the U. S. Public Health Service, and secured his approval of a constructive and far-reaching program for recognizing dentistry as an important phase of health service.

The articles in the January issue of THE JOURNAL stress two important problems:

1. The amount of dental service rendered at Government expense in the Veterans Bureau.

2. The effect on the practice of medicine and dentistry of the Final Report of the Committee on the Costs of Medical Care.

With reference to the former, I incorporate two items from our committee report submitted at Buffalo, which was approved by the Reference Committee on Legislation and the House of Delegates, as follows:

"(8) H. R. 8578, which passed the House of Representatives May 2, provides pensions for widows, minor children and orphans of veterans under certain stipulated conditions. This, half-enacted legislation, recognizes non-service connected cases, which is contrary to the views of those supposed to be best informed, especially in face of our economic conditions; therefore, it is recommended that this legislation be disapproved.

"(9) Also, for the same reason, it is recommended that the present law, providing hospitalization, disability allowance, etc., to veterans with non-service connected disabilities, be repealed."

Note that H. R. 8578 is only half-enacted legislation and we solicit your cooperation by requesting that you write both your United States Senators to oppose this legislation. In addition, write a strong letter of protest to Sen. Reed Smoot, chairman, and Sen. Pat Harrison, the ranking minority member of the Senate Finance Committee, to which this bill has been referred. Also, write Hon. John E. Rankin, chairman of the World War Veterans Committee of the House, expressing your disapproval of this legislation. This is suggested as a safeguard in the event that the bill should pass the Senate with some amendments necessitating that it go to conference for some adjustment. Further, in the same letter, please express your disapproval of the present law providing for hospitalization, disability allowance, etc., for veterans with nonservice disabilities, to the end that this legislation be repealed. Supplementing this, write your Congressman regarding the repeal of this non-service veterans legislation. A telegram just received from the secretary of the Senate advises that this question is being studied by a joint committee.

In support of these requests, please read the articles by Drs. Aison and Parkinson in the January issue of THE JOURNAL.

Further, we suggest that you also express disapproval of 3 cent postage on first-class mail. This has been the only class of mail service that has been self-supporting and there are opportunities to provide economies in other branches of the service, especially that wherein subsidies are provided, such as in foreign mail transportation.

For your general information, the following, which was submitted at the Buffalo meeting and approved by the Reference Committee on Legislation and the House of Delegates, is incorporated.

The following recommendations of your Chairman are attached to the Supplementary Legislative Report, as the other committee members have not participated in this.

A SUGGESTED PROGRAM FOR MORE EFFICIENTLY PROMOTING THE ACTIVITIES OF ORGANIZED DENTISTRY

(1) Stimulate an increase in the membership of the local, state and national organizations, through the following procedure:

(*a*) Develop a coordinated plan of educational publicity and promotion with the dental societies, journals, colleges, boards, manufacturers and dealers, in which emphasis should be placed on the benefits accruing to the profession and the public through the activities of organized dentistry since 1840, and particularly since the reorganization of the National Dental Association in 1913.

(*b*) Establish a direct contact with the various state societies to the end that an intensive membership campaign be promptly and simultaneously promoted in their components. In doing this, the following slogan would seem appropriate: "Every eligible dentist will be welcomed as a professional asset and every nonmember recognized as a potential liability."

(*c*) Fundamentally the practice of dentistry is a highly specialized health service and it is quite essential to stimulate a conception in the minds of both the public and the profession of the need for coordinating this service with that of the medical and allied professions in establishing and maintaining higher health standards.

(*d*) The American Dental Association should function, in at least an advisory capacity, in developing a program of dental service in connection with medical service in hospitals, institutions, clinics, public health organizations and school health programs. Provision should also be made for those who do not merit or seek charity, but are only able to pay moderate fees. However, sufficient flexibility should be provided to permit different localities developing the best possible cooperative arrangements with other local groups interested in general health promotion. In furthering this dental service program it would seem desirable to consider adopting a policy of dental internship in hospitals, institutions, clinics, schools, etc., which should assist in rendering service to a greater number of appreciative patients, as well as prove advantageous to many recent graduates.

(*e*) A program should be developed to promote dental representation on state and local boards of health, encouraging the establishing of divisions or bureaus, similar to the other major activities in such health organizations. In this connection, it would be most helpful if the United States Public Health Service could be interested in a problem of this nature. Like recognition should also be encouraged with boards of education, where the health programs of the schools are under their supervision.

(2) The American Dental Association should adopt a definite and constructive policy regarding uniform dental education, and uniform state dental laws, which should assist in some reasonable and practical reciprocity arrangements. Also, other uniform legislation and regulations, wherein the interests of the profession and the public will be best served, should be promoted.

(3) It is all important that the American Dental Association assume the leadership in advocating and directing policies in both Federal and state legislation and regulations. Whenever practical and feasible, it should cooperate with the American Medical Association, the state medical organizations and other recognized interests in health, education and allied activities to the end that self-seeking lay groups, with a possible socialistic bias, do not destroy the professional traditions and ideals which have required nearly a century of effort and sacrifice in achieving.

(4) There is nothing radical, impractical or impossible in the foregoing program; neither is there anything that should not be enthusiastically supported even under ordinary conditions. Moreover, under present economic conditions, with so-called panel or state dentistry and other menaces directly confronting us or as potential threats, we should be fully prepared to face these emergencies and assist in formulating whatever modifications are necessary to more efficiently meet present-day conditions and requirements. Being adequately prepared is a safe principle and a valuable asset, in any problem of life, regardless of whether it ever becomes necessary to call into action all of the reserve forces.

Respectfully submitted,

HOMER C. BROWN, *Chairman.*

609 Hartman Building

NEW PHARMACOPEIAL VITAMIN ADVISORY BOARD

When the U.S.P.X. appeared in 1925, its vitamin standards for cod liver oil represented the latest and most authoritative knowledge concerning vitamin A, and, while the presence of another factor was recognized, it was spoken of as "antirachitic activity" and the term "vitamin D" was only subsequently established. In the rapid development, during the past six years, of the knowledge concerning the place occupied by vitamins in nutrition and health, it has been considered desirable for the Pharmacopeia to announce an interim revision of its cod liver oil standards and of the methods for their determination.

Following a well-established policy of the U.S.P. Committee of Revision, a conference on vitamins was announced, and those interested were invited to attend. This group, about twenty-five in number, organized into a U.S.P. Vitamin Advisory Committee and prepared a report for submission to a vitamin conference which had been called by the Health Organization of the League of Nations to be held in London, June 17, 1931. Three of the members of our vitamin advisory committee were in attendance at the London conference.

When the results of the London Conference were made available a second meeting of the U. S. Pharmacopeial Vitamin Advisory Committee was called in New York.

At this New York meeting, the international units for vitamin A and vitamin D recommended by the League of Nations Conference were proposed for immediate adoption by the U.S.P.X. and these units were subsequently adopted by the U.S.P. Committee of Revision. This second New York Conference also recommended new vitamin standards for U.S.P. cod liver oil, to be expressed in international A and D units, and also detailed assay methods for their determination. It was further recommended that there be provided for distribution to manufacturers of products having vitamin A or D potency, a "reference cod liver oil" of known vitamin A and vitamin D potency, expressed in international units, to be used in a basis of comparison in vitamin assays.

This entire plan subsequently received the approval of the U.S.P. Committee of Revision and Board of Trustees.

In the meanwhile the League of Nations Committee had arranged for the distribution to all countries interested in vitamin standardization, a limited amount of the International units, consisting of "carotene" for vitamin A and a special irradiated ergosterol for vitamin D, these having been prepared by the National Institute for Medical Research, London, England, under the supervision of Sir Henry Dale.

It was hoped at the start that the Food and Drug Administration of the Department of Agriculture at Washington would be in a position to distribute in this country both the international vitamin units for scientific purposes, and the "reference cod liver oil," of known potency, for the standardization of commercial vitamin products; but as this was found to be impracticable, the Pharmacopeial Vitamin Advisory Board was organized, with the approval of the U.S.P. Board of Trustees, for the preparation and distribution of vitamin standards within the United States. The U.S.P. Vitamin Advisory Board consists of Drs. Lafayette B. Mendel, Yale University, New Haven, Conn.; H. C. Sherman, Columbia University, New York City, and E. M. Nelson, Protein and Nutrition Division, Bureau of Chemistry and Soils, Department of Agriculture, Washington, D. C.; and Messrs. E. F. Kelly, Baltimore, Md., representing the U.S.P. Board of Trustees, and E. Fullerton Cook, Philadelphia, Pa., representing the U.S.P. Committee of Revision.

Plans have now been developed by this Board, which make it possible to announce at this time the following program for the distribution of vitamin standards in the United States:

Scientific laboratories and research workers may obtain the international standard carotene, for vitamin A, also the international standard irradiated ergosterol, for vitamin D, and the international standard activated clay for vitamin B, either through Dr. E. M. Nelson, Protein and Nutrition Division, Bureau of Chemistry and Soils, Department of Agriculture, Washington, D. C., or through the U. S. Pharmacopeial Vitamin Advisory Board, 43rd Street and Woodland Avenue, Philadelphia, Pa.

The international vitamin standards are issued to serve only in vitamin assays. The quantities distributed are suitable only for assays with small laboratory animals such as rats, pigeons and mice.

These international vitamin standards, sent to this country by the Permanent Standard Commission of the Health Organization of the League of Nations, are issued without cost but only for scientific research.

The "reference cod liver oils" of known vitamin A or vitamin D potency, expressed in international units, will be distributed only by the U. S. Pharmacopeial Vitamin Advisory Board, 43rd Street and Woodland Avenue, Philadelphia, Pa., and are the only standards available for the use of the commercial laboratories of the United States for the standardization of products containing vitamin A and vitamin D.

The U.S.P. Vitamin Board has also assisted in securing an authentic lot of U.S.P. cod liver oil, through the Bureau of Fisheries at Washington, and this oil is being packaged in 30 c.c. glass containers and will be kept constantly under refrigeration. This oil will now be assayed for its vitamin A and vitamin D potency in comparison with the international units and its vitamin activity determined by the new U.S.P. assay methods, which will be strictly followed. When this is done these "reference oils" will be ready for distribution for the standardization of cod liver oils and other vitamin-active products.

Uniform report blanks will be supplied

by the U.S.P. Vitamin Board for the use of the laboratories cooperating in the standardization of the reference oils. All reports will be listed under a code number and all laboratories participating will be sent all reported results.

It is expected that until the Board has secured more data on the subject of vitamin deterioration in cod liver oil, the "reference oils" will be reassayed each six months.

E. FULLERTON COOK, *Chairman,*
U.S.P.XI Committee of Revision.

CORRESPONDENCE

"GOVERNMENT COMPETITION WITH PRIVATE PRACTICE"

To the Editor:

I have never before written an editor concerning an article in THE JOURNAL and would not do so now were it not for the fact that you have commented editorially on Dr. Aison's article in the January issue.

Does the editor think that the dental work done by the Veterans Bureau can have any serious effect on the income of the dentists in private practice? I call your attention to the fact that if all the dentistry done by the Veterans Bureau were divided among the dentists in private practice, it would amount to only about thirty dollars each. The fact is that if there were no Veterans Bureau dentistry done, not more than one third of the work would ever be done, because of inability to pay. Another fact is that no matter where this dentistry is done, it will take dentists to do it. These dentists are taken out of private practice so I cannot see how it can be said that private dentistry is the loser.

As to whether the veteran is entitled to a pension, I would like to ask the author what superknowledge he has that makes it possible for him to know what is service connected and what is not service connected.

Does the author know that most of the pensions for so-called nonservice cases are border-line cases that are, in many instances, actually of service origin, but application was not made soon enough because the veteran would not make application as long as he could make a living?

Can the author tell me the difference between the man injured by gun fire and the man who has a heart lesion from change of altitude and overexertion?

Has the author ever visited a district Veterans Bureau office? If so, did he think the men seemed deserving or did they appear to be men in good health trying to graft off the government?

Does the author follow the Congressional Record? If so, has he paid close attention to the appropriation bills? I call his attention to the fact that, in one instance at least, the government is paying $5,000 a pound to a shipping company to carry mail. Also, I call attention to the fact that it is costing the government $3.00 a pound to carry mail by air. Does the author not think that the veteran is more deserving than these shipping and aeroplane companies?

Does the author realize that many of these veterans would be dependent on charity if it were not for the small pension they get? I know several cases in which the only income the family has is from a $12 a month pension.

Does the author know that the percentage of the national revenue going to veterans of the World's War is smaller than the percentage going to veterans in the year 1878?

Does the author know that a totally disabled veteran of the World War with several dependents, if his condition is of nonservice origin, gets only about half as much as the veteran of the civil war, who probably has grown children? Surely any veteran of the Civil War who is still living could not have been very badly disabled.

Which does the author think is costing the dentists of the United States the most, the veteran or the tariff that makes it possible for the dental dealer to get $350 for a dental chair, $6 for a standard pair of forceps and everything else in proportion?

I cannot see how THE JOURNAL can feel that it becomes its duty to strike at veterans when the percentage of the dentists who pay any income tax is so small, and they in the lower brackets.

JOHN W. LAYNE,
Eldon, Mo.

Jan. 2, 1933.

To the Editor:

Replying to Dr. Layne's criticism on my article "Government Competition with Private Practice" which appeared in the January issue of THE JOURNAL: It is natural that there should be a divergence of interest and opinion concerning matters affecting public or national welfare. Yet, I hold to the premise that the rights and prerogatives of any one single group in a free government must not conflict with the welfare of the rest of the people if these rights are to

sustain themselves, because of the natural correlation and interdependence of groups in civilized society.

We must never lose sight of the most outstanding fact in connection with the history of America's participation in the World War, that we did not enter it for profit, individual or national. The flower of America's youth joined the colors as a matter of patriotism and duty. At the end of the War, it became this nation's highest pride to reward its veterans for wounds or material losses sustained in her service. Billions of dollars were spent for this purpose without stint or protest. This is just enough, but justice is one thing and pension-grabbing is another. As a veteran, I am fully conversant with the sacrifices and hardships of the service men and would defend with every bit of my strength the rights of any ex-soldier justly entitled to government compensation or medical and dental care. There is not space here to delve deeply into even a small portion of the flagrant major and minor abuses of the system of government benefaction. The fully documented case histories of individual pension-grabbers fourteen years after the end of the War for supposed injuries of varying character from fallen arches, a bump in a friendly scuffle on boat, injury to a knee in a wrestling match in a camp in Texas, mumps in a hospital in France, loss of a loose bridge and infected roots, bronchitis developed in an office in Washington, to cases of venereal and other unheroic diseases, fill a library. Deserving veterans there are. Even the most virulent denouncer of pension raids would take up the cudgels for the man really marred by the rigors of his military service. The best informed authorities on the subject are agreed that the act allowing compensation, or medical and dental treatment, for nonservice disabilities, has no moral excuse; and that, of the $1,000,000,000 a year spent on veteran's relief, at least $400,000,000 of this amount can be cut without loss to any sufferer from any war in which this country was involved. An analysis of the reports recently compiled by official and semiofficial agencies about the cost of veterans' compensation shows what it all means to the rest of our citizenry. The United States, which had 344,000 killed or wounded in the World War, is now footing a veterans' relief bill that, in one year, figures to 20 per cent more than the combined veterans' payments of England, France, Germany, Italy and Canada, whose dead and wounded totaled 16,500,000 men. The 1932 cost of veterans' relief in the United States is more than a billion dollars, 25 per cent of the national expenditures, and one quarter out of every dollar of taxes collected by the government. The combined cost of veterans' relief in England, France, Germany, Italy and Canada is slightly over $800,000,000. Since the War, the annual cost of veterans' relief has shown a steady decline in all combatant nations except the United States, where the yearly bill has grown by leaps and bounds. Reports recently compiled by Representative Nelson (Rep. Wis.), former chairman of the house committee on invalid pensions, discloses that every major combatant nation of the World War, with the exception of the United States, pays pensions and compensations to exservice men who can prove their disability "is attributable to or aggravated by military service during the war." In the United States, veterans' compensation laws are so broad of interpretation that veterans must obtain only a perfunctory medical examination as proof that disability is attributable to war service. Likewise, development of certain diseases, notably tuberculosis and spinal meningitis, prior to Jan. 1, 1925, is presumed, under the laws of the United States, to be conclusively of service connection. In such a case, the veteran is entitled to $50 a month for life, even though the condition was cured and the exservice man is engaged in normal occupation. In 1931, there were nearly 21,000 veterans, rated "no disability" or "cured" by the Veterans Bureau, drawing more than $1,000,000 a month under this classification. The total number of American wounded in the war was 214,000. It should be noted that two thirds of the wounded were able to return to duty and that this caused many duplications: a wounded man returning to duty and wounded again, would appear twice in the grand total. Hence, a generous estimate of the number of wounded living at the present time would be 200,000. Last March, 800,000 veterans were drawing pensions for disabilities, a great part of which, according to most liberal official calculation, have no connection with their war service A total of 53,371 men were killed in action or died of wounds,. and 76,697 died from disease (including influenza, during the epidemic). It is significant that to the widows

and dependents of these 130,068 dead the United States pays $36,000,000 a year. But to the survivors, most of whom suffered no injury whatsoever in the war, the United States pays in pensions and other benefits including medical and dental care $650,000,000.

Medicine and dentistry in America is interwoven with the public weal as a whole. No single group can escape the demoralizing effects of privileged class legislation by which one set of people is nourished on the fat of another or benefits by the paternalism of the government. The vicious circle resulting from unjust taxation for the support of those not entitled to it ruins our national credit, discourages individual enterprise, retards the progress of business, causes unemployment and privation and eats into the very vitals of our nation.

Medicine and dentistry did not and will not escape its share of the burden until this evil is eradicated. There are undoubtedly, as Dr. Layne points out, other evils of waste and mismanagement in the affairs of our government calling for correction. But that is no reason for approving tacitly or otherwise the upkeep of this sacred white elephant which takes Uncle Sam's every fourth dollar. We are shaking our heads over England's "dole," but few of us know that the United States is spending in a single year on her veterans as much as England spent on the dole the whole eleven years from 1920 to 1931.

Drastic curtailment of the cost of government, equitable revision of the tariff, etc., are our new administration's first concern and we have reason to hope that these important adjustments will have priority.

EMIL AISON,
55 E. Washington St.,
Chicago, Ill.

Jan. 5, 1933.

DENTAL INTERNSHIPS

To the Editor:

In the December number of THE JOURNAL is a list of states which do and states which do not have dental internships in hospitals. Oregon is listed among those that do not. On the contrary, this state has an internship in two hospitals and an outpatient clinic, all of which are connected with the University of Oregon Medical School.

This internship is not limited in its activities as are ordinarily those internships connected with hospitals. The University of Oregon Medical School has a department of dental medicine, which is a subdivision of the Department of Medicine. This department, of which I am the head, is conducted on lines similar to those of the Department of Dental Pathology at Yale Medical School, although, we think, in a more practical manner, and furnishes medical instruction to a greater number of practicing dentists.

In no way is this work of the medical school connected with the local dental school. There are on my staff fifteen dentists besides the intern, above mentioned. Of these, the intern, continuously throughout the year, under my direction and that of other members of the staff in rotation, maintains a service which is in daily consultation with the medical clinical staff in the outpatient clinic in treatment of patients. Thus, every day from 8:30 a. m. to 12 m., there are at least two dentists on duty in the outpatient clinic and the hospitals. During the remainder of the day, the intern is on duty alone. The service in hospitals through weekly or more frequent rounds is under my direction alone and the medicodental work is carried on by the intern, and one or more of my staff members, in accordance with the instructions to him.

No dental service in the way of mechanics is rendered. The service is designed as a movement for the training of medical students in some knowledge of oral disease and for the treatment of patients in the three institutions above mentioned. Classes are held also by members of the hospital staffs and the faculty of the medical school for the dental staff, whereby we are receiving instruction in general histology, general pathology, clinical medicine, and other medical subjects. Our department, in connection with the department of pathology of the medical school, is engaged also in research on medicodental problems from specimens secured from patients in the hospitals and outpatient clinic. We make also a complete oral examination as a part of the health service of all the medical students, especially directed to oral disease as a causative factor in general disease.

The department of dental medicine is also engaged in attempting research to show if possible oral disease affecting the blood stream whether or not clinical disease is present. I believe that our entire activity is doing much on the foregoing lines for both medicine and dentistry and is more nearly closing the gap between medical education and dental education than is being done in any other school or

hospital in the country. It is being extended throughout the Pacific coast to other hospitals and their staffs whether conducted in connection with medical schools or not.

The information contained in this letter could well be published as a guide to other educational movements in the country, as it is believed our plan will solve some controversial subjects in education and practice in both medicine and dentistry.

I might add that, during the year, there was published in your journal two articles in connection with some of the clinical and pathologic work of our department which was sent to you by a former intern, the reports evidently having been written by members of the medical staffs.

ARTHUR W. CHAUER, D.D.S., M.D.,
Portland, Ore.

Dec. 10, 1932.

NEWS

Dr. Wherry Honored: Arthur C. Wherry, President Elect of the American Dental Association, was recently honored by a dinner given by members of the Utah State Dental Association and attended by the governor, governor elect and others prominent in governmental, lodge, church, educational and medical circles. In thirty years' practice in dentistry, Dr. Wherry has been active in national and state dental organizations, serving at one time as president of the state society and recently as vice president of the national organization.

Allied Dental Council Opposes Licensure of Technicians: At a recent meeting, the Allied Dental Council, Inc., of New York City, went on record as reaffirming its stand as being opposed to any form of legislation which seeks to license dental laboratories or dental technicians, stating further that it will use every means at its command in its opposition to such legislation. Secondly, it went on record as requesting the board of regents of the council to adopt a new rule which will prohibit all forms of dental advertising not in accord with the rules of ethics of the American Dental Association and of the Allied Dental Council. Joseph H. Kauffmann is president of the organization and M. Alden Weingart, secretary.

Eastern Society of Dental Anesthetists Elects Officers: The Eastern Society of Dental Anesthetists, at the regular meeting held December 12, elected the following officers: honorary president, H. M. Seldin; president, Daniel Brown; president-elect, John B. Woodman; vice president, Philo F. Hildebrand; secretary, Samuel L. Binder; treasurer, Roy Regan. Membership is open to members of the America Dental Association or others abiding by the Code of Ethics of the A. D. A.

DEATHS

Barnhill, Paul Vaith, Fort Wayne, Ind.; Indiana School of Dentistry, 1914; died, January 4; aged 40. Dr. Barnhill served as a lieutenant in the Dental Corps during the World War, seeing service at Chateau-Thierry, the Battle of the Marne and in other engagements. At the time of his death, he was president of the Isaac Knapp District Dental Society. The parents, two sisters, the widow, a son, aged 11, and a daughter, aged 8, survive.

Soik, Edward J., Two Rivers, Wisc.; Northwestern University Dental School, 1898; died suddenly, December 8; aged 57. The widow, a son, a daughter and a granddaughter survive.

Wumpes, William W., Sioux Falls, S. D.; Chicago College of Dental Surgery, 1915; a former member of the state legislature, died, January 11; aged 48.

ANNOUNCEMENTS*

CALENDAR OF MEETINGS

American Dental Association in conjunction with the Chicago Centennial Dental Congress, Chicago, Ill., August 7-12.

American Board of Orthodontia, Oklahoma City, Okla., April 17-18.

American Dental Society of Europe, Le Touquet, France, April.

American Society of Orthodontists, Oklahoma City, Okla., April 19-21.

Buffalo University School of Dentistry Alumni Association, Buffalo, N. Y., March 1-3.

Central Pennsylvania Seventh District Dental Society, Johnstown, February 27-28.

Fédération Dentaire Internationale, Edinburgh, July 22-27.

Great Lakes Association of Orthodontists, Cleveland, Ohio, February 27-28.

Society for Advancement of General Anesthesia in Dentistry, New York City, third Monday in February, April, October and December.

St. Louis University Dental Alumni Reunion, St. Louis, Mo., March 31-April 1.

Thomas P. Hinman Midwinter Clinic, Atlanta, Ga., March 13-14.

Tufts College Dental Alumni Association, Boston, Mass., March 8.

Washington University Dental Alumni Association, St. Louis, Mo., February 20-22.

Dental Hygienists Association of State of New York, Syracuse, May 11-13.

STATE SOCIETIES

District of Columbia, at George Washington University, Washington, D. C., second and fourth Tuesdays in each month from October to June, inclusive.

February

Minnesota, at Minneapolis (7-9).

April

Alabama, at Birmingham (24-26).
California (State), at Del Monte (20-22).
Connecticut, at Bridgeport (19-21).
Kansas, at Topeka (24-26).
Kentucky, at Louisville (3-5).
Michigan, at Grand Rapids (10-12).
Montana, at Billings (20-22).
New Jersey, at Atlantic City (26-28).
Oklahoma, at Oklahoma City (17-20).
Tennessee, at Knoxville (27-29).
Virginia, at Richmond (24-26).

May

Illinois, at Peoria (9-11).
Indiana, at Indianapolis (15-17).
Iowa, at Des Moines (2-4).
Maryland, at Baltimore (1-4).
Massachusetts, at Boston (1-4).
Missouri, at St. Louis (15-17).
Nebraska, at Omaha (15-18).
New York, at Syracuse (11-13).
Pennsylvania, at Philadelphia (2-4).
South Carolina, at Columbia (22-23).
Texas, at San Antonio (9-11).
Vermont, at Burlington (17-19).
West Virginia, at Charleston (15-17).

June

Arkansas, at Little Rock (5-7).
California (Southern), at Los Angeles (5-7).
Colorado, at Colorado Springs (19-21).
Georgia, at Savannah (12-14).
Maine, at Rangeley Lake (22-24).
Nevada, at Reno (3).
North Carolina, at Chapel Hill (6-8).
Oregon, at Portland (21-24).
Utah, at Ogden (1-3).
Washington, at Yakima (June 30-July 2).

STATE BOARD OF DENTAL EXAMINERS

California, at San Francisco, May 22, and Los Angeles, June 19. K. I. Nesbitt, Secretary, 450 McAllister St., San Francisco.

Iowa, at Iowa City, May 29-June 1. Hardy F. Pool, Secretary, Mason City.

Kentucky, at Louisville, June 7-10. Robert L. Sprau, Secretary, 970 Baxter Bldg., Louisville.

New Jersey at Trenton, June 26-July 1. John C. Forsyth, Secretary, 148 W. State St., Trenton.

*Announcements must be received by the fifth day of the month in order to be published in the forthcoming issue of THE JOURNAL.

STATE BOARD OF REGISTRATION AND EXAMINATION IN DENTISTRY OF NEW JERSEY

The State Board of Registration and Examination in Dentistry of New Jersey will hold its regular examinations at Trenton commencing June 26 and continuing for five days thereafter. The examination fee is $25; reexamination, $10. Application must be filed complete ten days before the date of examinations. Address all communications for further particulars to

John C. Forsyth, *Secretary*
148 W. State St.
Trenton

CALIFORNIA STATE BOARD OF DENTAL EXAMINERS

The next examination of the California State Board of Dental Examiners will be held May 22, in San Francisco, and June 19, in Los Angeles. All credentials must be in the office of the board not later than twenty days prior to each examination. For further information, address

K. I. Nesbitt, *Secretary*
450 McAllister St.
San Francisco

BOARD OF DENTAL EXAMINERS, IOWA STATE DEPARTMENT OF HEALTH

The next examination of applicants to practice dentistry in Iowa will be held at the State University of Iowa College of Dentistry, Iowa City, May 29-June 1. Applications properly executed, together with college diploma and fee of $25, must be filed with the State Department of Health, State House, Des Moines, at least fifteen days prior to the date of examination.

Hardy F. Pool, *Secretary*
Mason City

AMERICAN BOARD OF ORTHODONTIA

The fourth annual meeting of the American Board of Orthodontia will be held in Oklahoma City, Okla., at the Hotel Biltmore, April 17-18. Those orthodontists who desire to qualify for a certificate from the board should secure the necessary application form from the secretary. For further information also address the secretary, Oren A. Oliver, Medical Arts Bldg., Nashville, Tenn.

FÉDÉRATION DENTAIRE INTERNATIONALE

The next meeting of the Fédération Dentaire Internationale will be held at Edinburgh, July 22-27. The date selected will enable those who desire to attend both this meeting and the joint meeting of the American Dental Association and the Chicago Centennial Dental Congress, August 7-12, to do so.

A. E. Rowlett, *Treasurer*
165 London Road
Leicester, England

NEW YORK SOCIETY OF ORTHODONTISTS

The annual meeting of the New York Society of Orthodontists will be held at the Hotel Waldorf Astoria, Park Ave., New York City, March 13-14.

Franklin A. Squires, *Secretary*
Medical Centre
White Plains

KINGS COUNTY DENTAL SOCIETY

Midyear Clinic Day will be held under the auspices of the Kings County Dental Society, February 17, at the Allied Dental Council Headquarters, 425 LaFayette St., New York City.

J. Rosenthal, *Chairman*
Publicity Committee
62 Hanson Place
Brooklyn, N. Y.

ST. LOUIS UNIVERSITY DENTAL ALUMNI REUNION

The annual reunion of the St. Louis University Dental Alumni will be held in the university gymnasium, 3672 W. Pine Blvd., March 31-April 1.

TUFTS DENTAL ALUMNI ASSOCIATION

Tufts College Dental Alumni Association will hold its midwinter meeting at the school, 416 Huntington Ave., Boston, Mass., March 8.

L. E. Sager, *President*

AMERICAN SOCIETY FOR THE ADVANCEMENT OF GENERAL ANESTHESIA IN DENTISTRY

The next meeting of the American Society for the Advancement of General Anesthesia in Dentistry will be held at the Barbizon-Plaza Hotel, 58th St. and 6th Ave., New York City, February 28, commencing with a dinner at 7 p. m.; scientific session at 8:15.

Leonard S. Morvay, *Secretary*
76 Clinton Ave.
Newark, N. J.

EASTERN SOCIETY OF DENTAL ANESTHETISTS

The next meeting of the Eastern Society of Dental Anesthetists will be held February 17 at the Hotel Westover, 72d St., west of Broadway, New York City. Dinner at 7 p. m. will be followed by a lecture, at 8:15.

SAMUEL L. BINDER, *Secretary*
624 Bergenline Ave.
West New York, N. J.

DENTAL HYGIENISTS ASSOCIATION OF STATE OF NEW YORK

The thirteenth annual meeting of the Dental Hygienists Association of the State of New York will be held in Syracuse at the Hotel Onondaga, May 11-13.

MARY A. OWEN, *Publicity Chairman*
28 Tremaine Ave.
Kenmore

DENTAL INTERN

The position of dental intern at the Lenox Hill Hospital will be vacant, September 1. The term of service is one year, with full maintenance. Apply in writing not later than March 15 to

JOHN H. HAYES, *Superintendent*
111 E. 76th St.
New York City

PROSTHODONTIA SECTION OF THE FIRST DISTRICT DENTAL SOCIETY OF NEW YORK CITY

Notice of change of meeting place

The future scientific meetings of the Prosthodontia Section of the First District Dental Society of New York City will be held at the Hotel Pennsylvania, Seventh Avenue and Thirty-Third Street, New York City. A symposium on "Dental Ceramics" will be presented on February 27, at 8:15 p.m. A round table topic discussion clinic will be given by the essayists following the symposium.

LOUIS I. ABELSON, *Chairman*

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1932-1933

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